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When to Install VSD Chillers

Spencer Fuller and Fred Berry, *Johnson Controls*
Keynote Speakers

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The recording and slides of this webinar will be made available to attendees via email later today.

PDH Certificates will be e-mailed to Attendees within two days.

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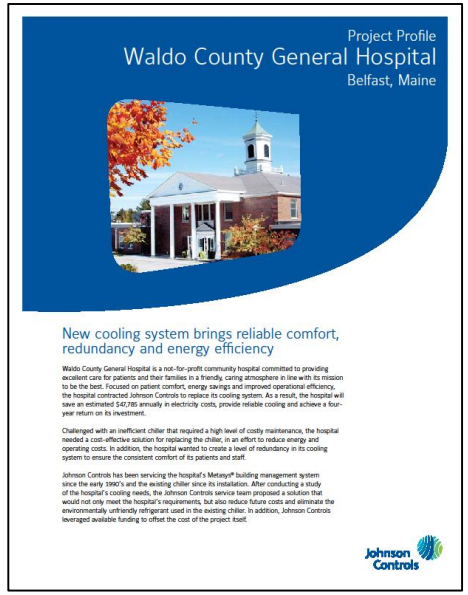
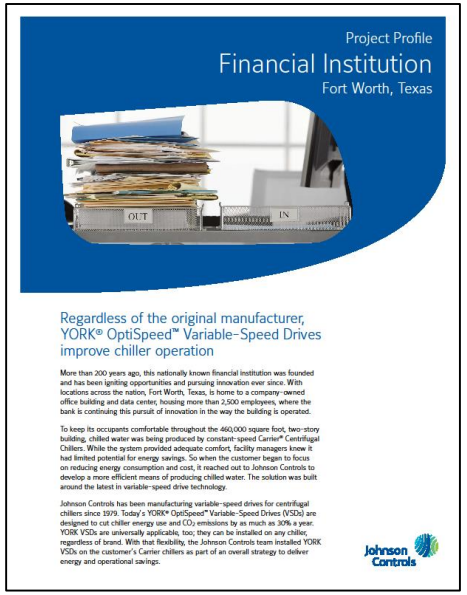
Handouts





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All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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When to Install VSD Chillers

Introduction by *Rod Smith*, Publisher

Chiller & Cooling Best Practices Magazine

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About the Speakers

Spencer Fuller

• North America Portfolio Manager for Johnson Controls

•Chiller Product Manager of YMC²

Fred Berry

• Chiller Product Manager of Large Tonnage Chillers and Electronic Products for Johnson Controls

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OPTIMIZING ENERGY USE WITH VSD CHILLERS

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Today's Agenda

- Real World Efficiency
- Lift vs. Load
- Benefits of VSD technology
- More chillers operating is more efficient
- Constant load with VSD saves money
- Air-Cooled chillers with VSD technology
- Conclusion

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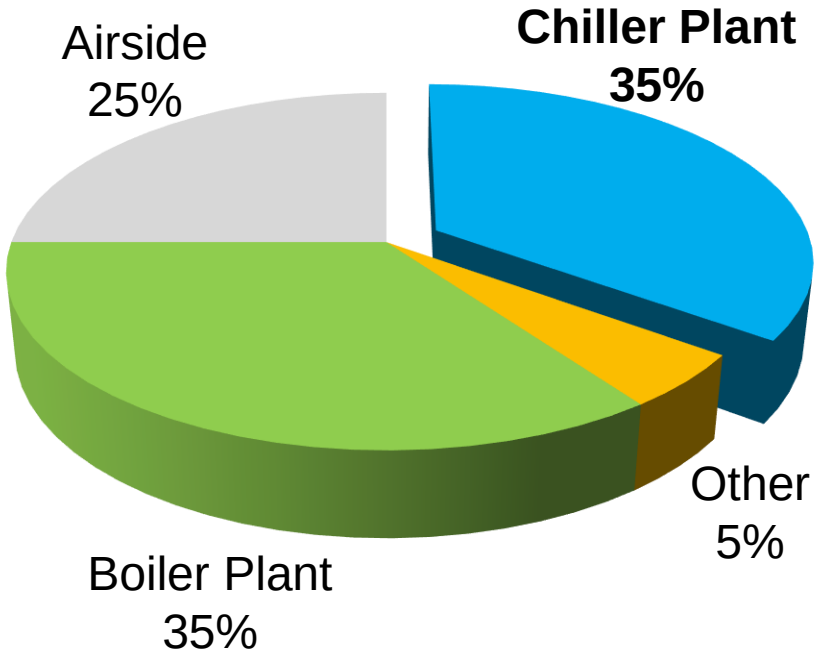
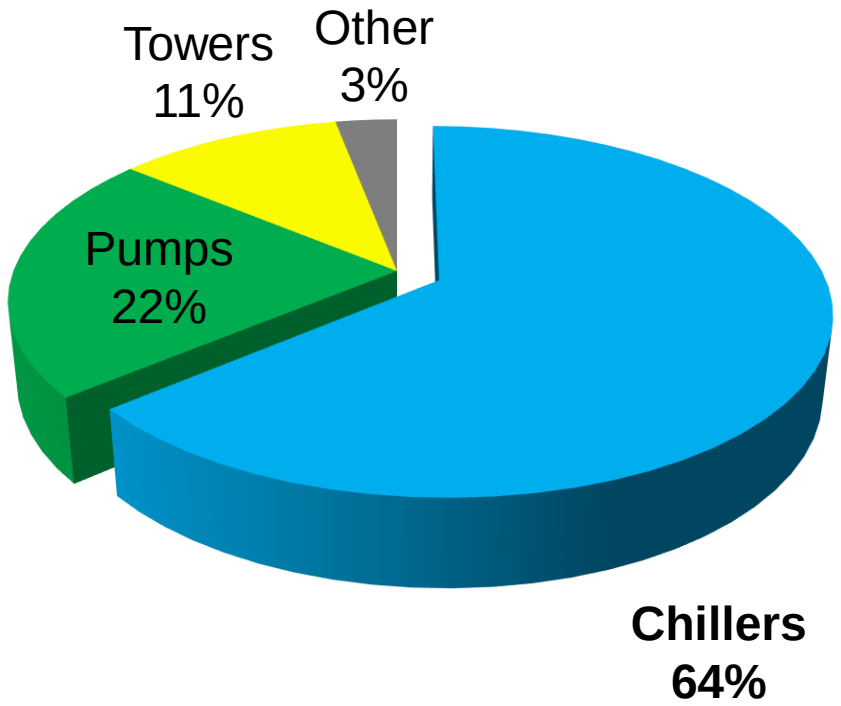
Addressing Sustainability

Chiller Energy Consumption is Critical to Driving Sustainability

Total HVAC Energy Use for Commercial Building Utilizing Water Cooled Systems



Total Chiller Plant Energy Use



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Understanding the Impact of Energy Efficiency

Centrifugal chillers are the largest single energy consumer in the building.

Energy Costs vs. First Costs

First Costs
Typical 1000 TR
$300,000 Equipment only

Annual energy cost is ~ 41% of first cost

A keen focus on real world energy performance delivers real value

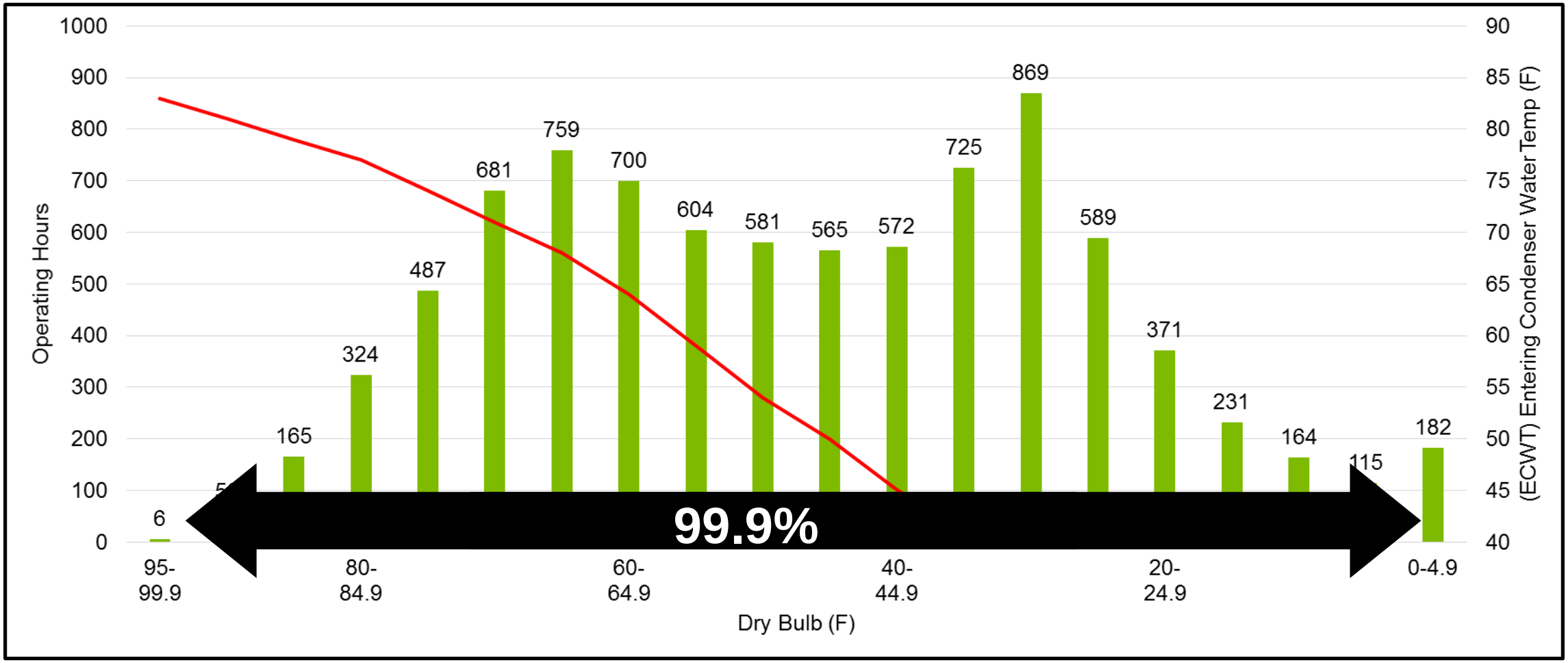
Energy Over Chiller Lifetime

Lifetime energy cost is ~ $6M

How often do we operate our buildings at design conditions?

Real World Energy Performance

The Operating Envelope – Chicago, IL Weather



Chillers run at "full-load design" conditions Less than 1% of the time!

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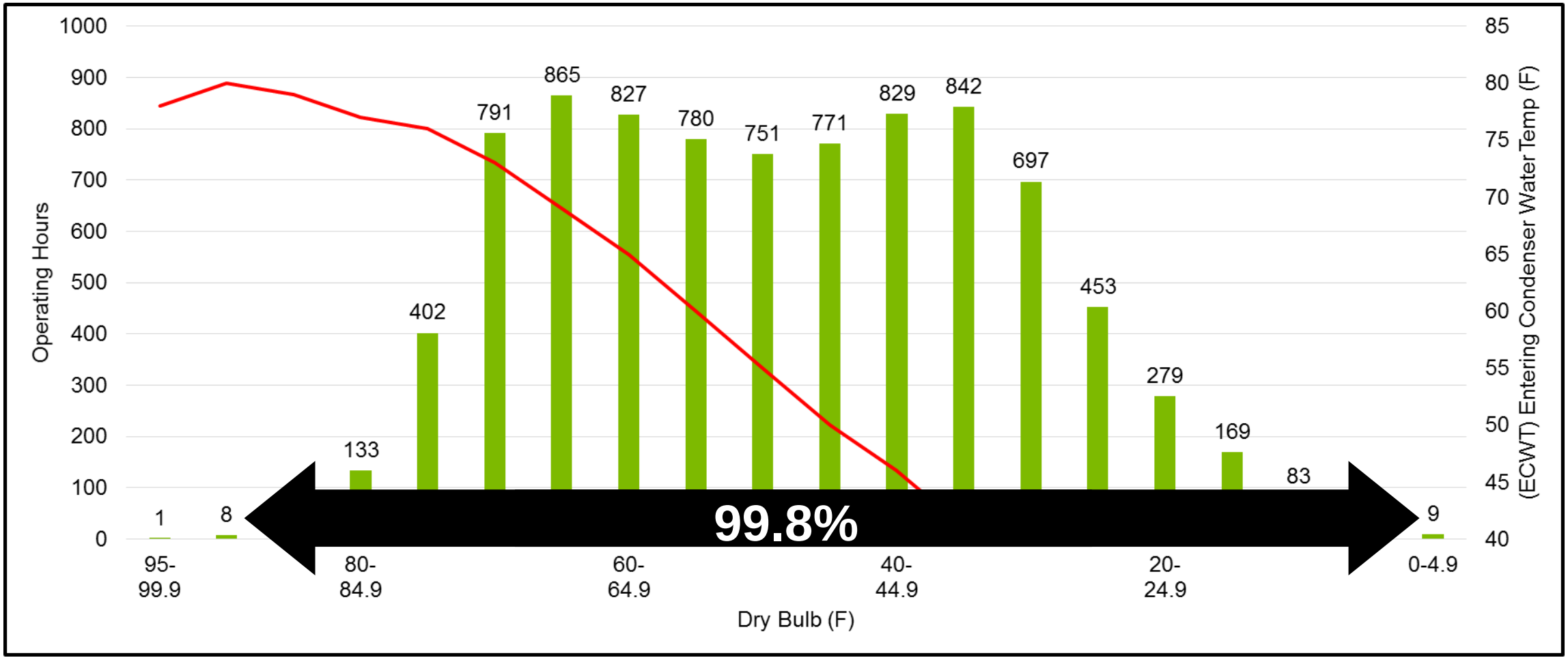
Real World Energy Performance

The Operating Envelope – New York City, NY Weather



Chillers run at "full-load design" conditions Less than 1% of the time!

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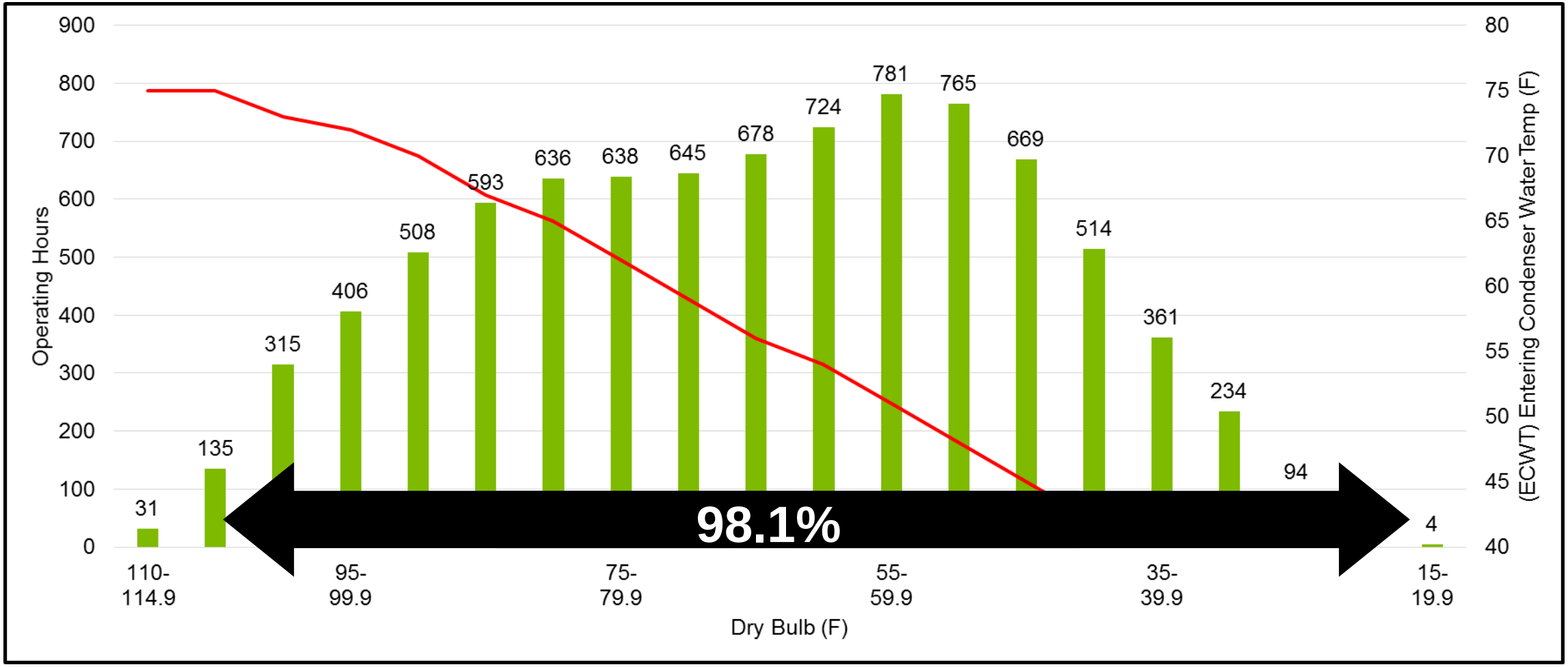
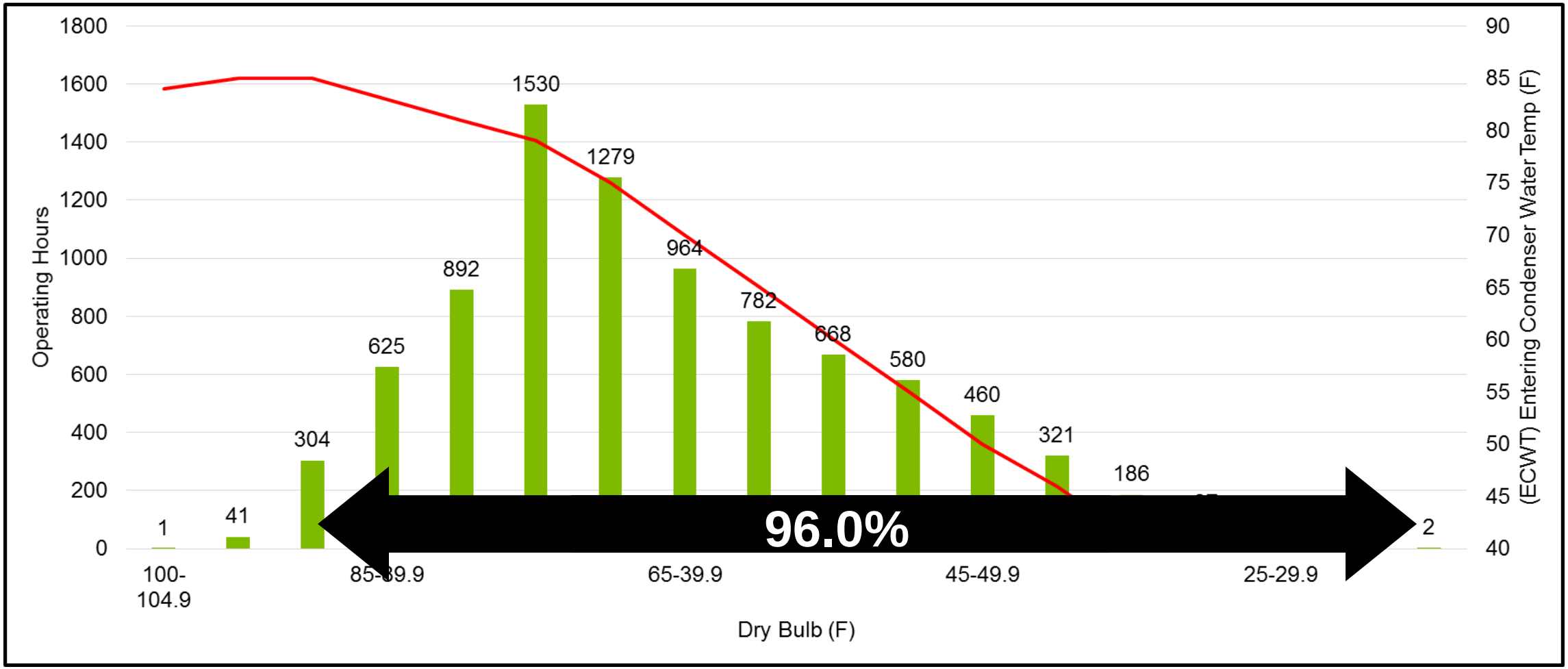
Real World Energy Performance

The Operating Envelope – Las Vegas, NV Weather



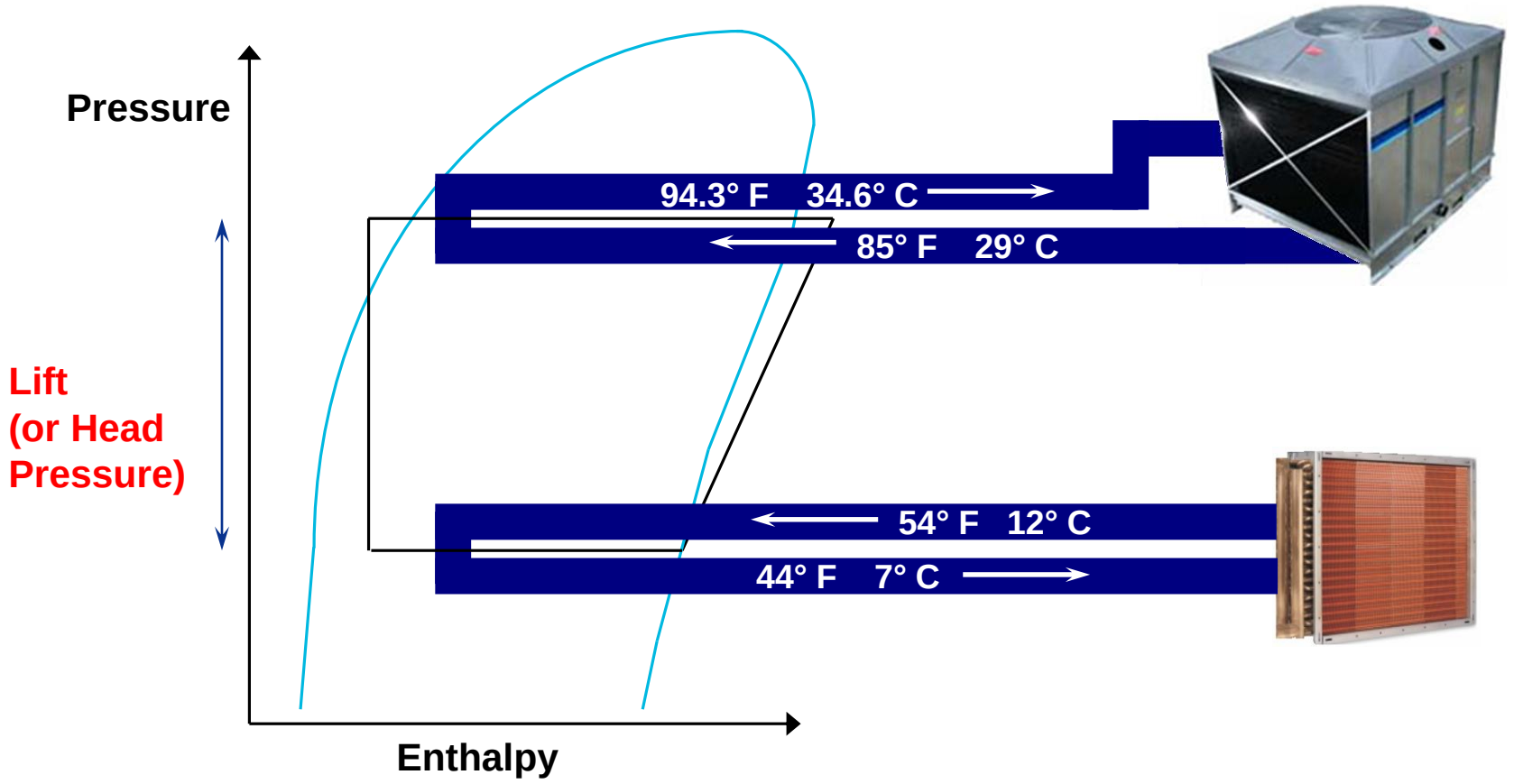
Real World Energy Performance

The Operating Envelope – Houston, TX Weather



Centrifugal Chillers in Today's Complex Buildings

How They Work



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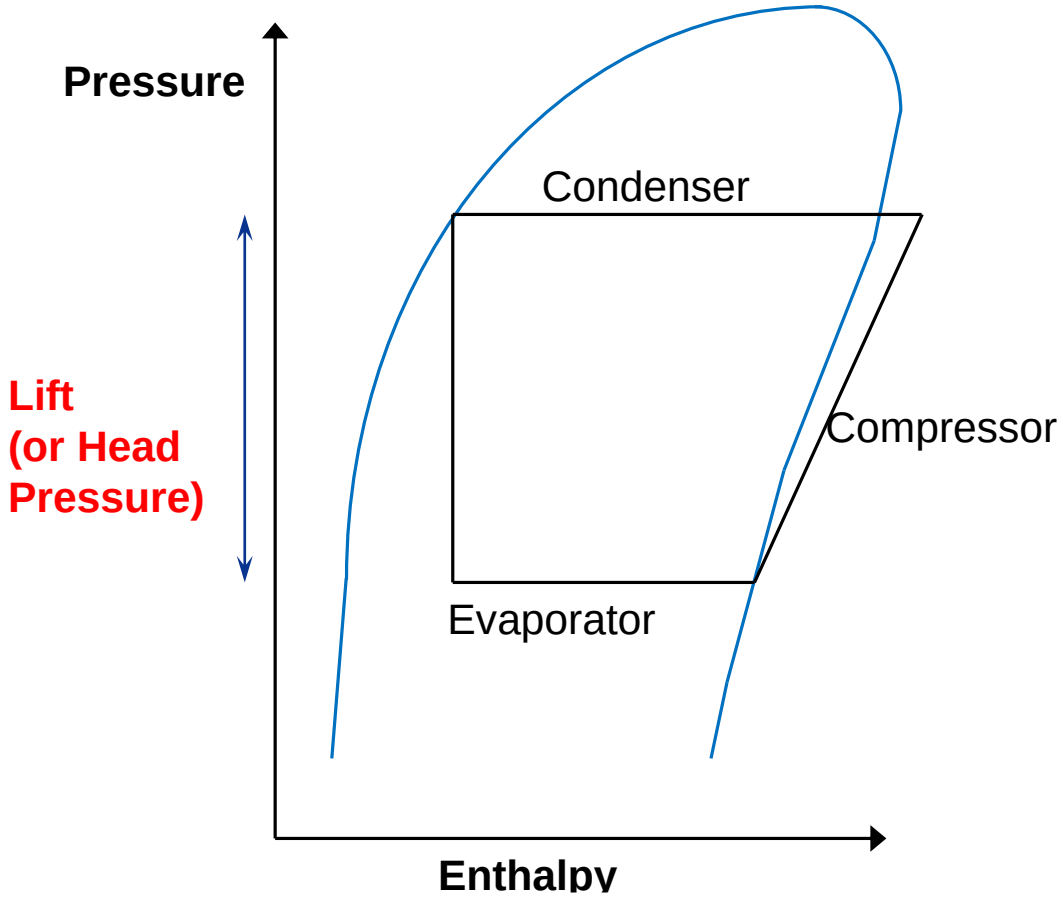
Real World Energy Performance

Capitalizing on Part Load Conditions



Lowering Condenser Water Temperature

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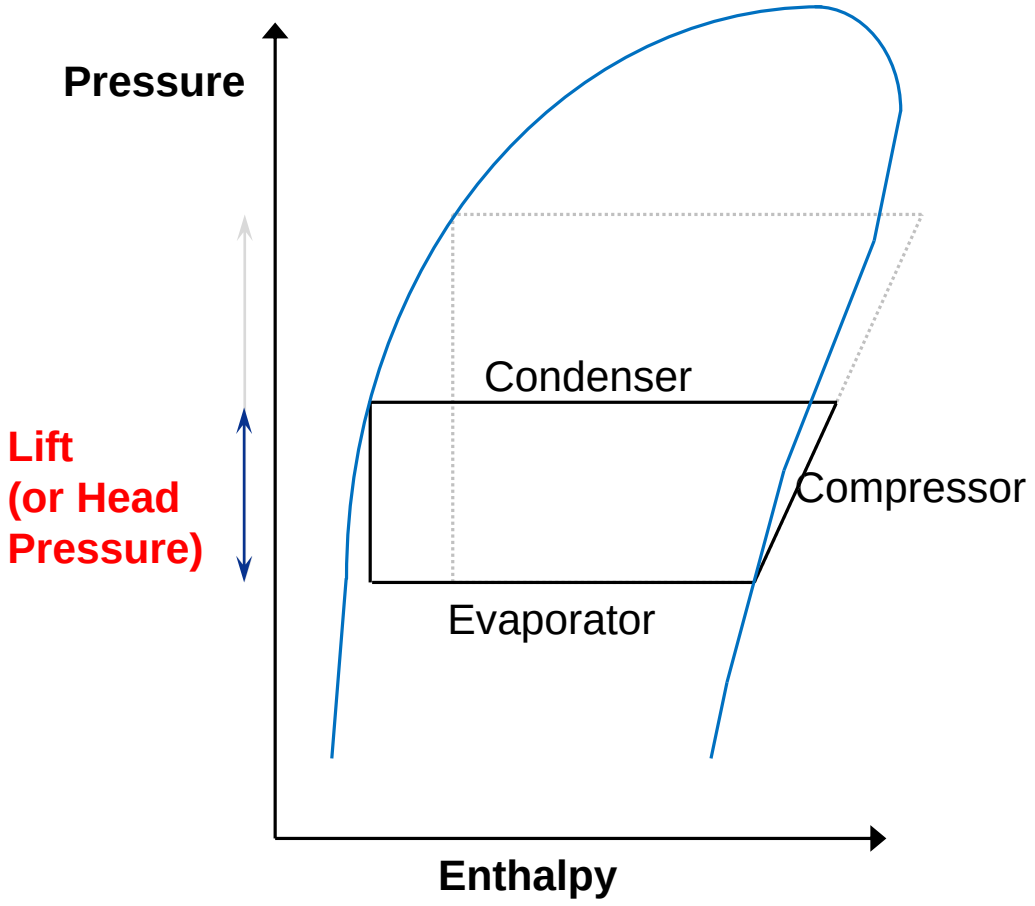
Real World Energy Performance

Capitalizing on Part Load Conditions



Lowering Condenser Water Temperature

↓

Lowers the Lift

↓

Reduces Compressor Work

↓

Reduces Energy Consumption

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Rule of Thumb

Component power

- Cooling Tower = 5hp/100ton
- Pumps (2x) = 10hp/100ton
- Chiller = 70-80hp/100ton

Chiller efficiency improvements

- 1 degree colder ECWT is up to 2% efficiency improvement
- 1 degree warmer LCHWT is up to 3% efficiency improvement

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Rule of Thumb

Component power

- Cooling Tower = 5hp/100ton
- Pumps (2x) = 10hp/100ton
- Chiller = 70-80hp/100ton

Ex: 500 TR Chiller

- Cooling Tower = 25hp = 18.75kW
- Evap Pump = 25hp = 18.75kW
- Cond Pump = 25hp = 18.75kW
- Chiller = 390hp = 292.5kW

Chiller efficiency improvements

- 1 degree colder ECWT is up to 2% efficiency improvement
- 1 degree warmer LCHWT is up to 3% efficiency improvement

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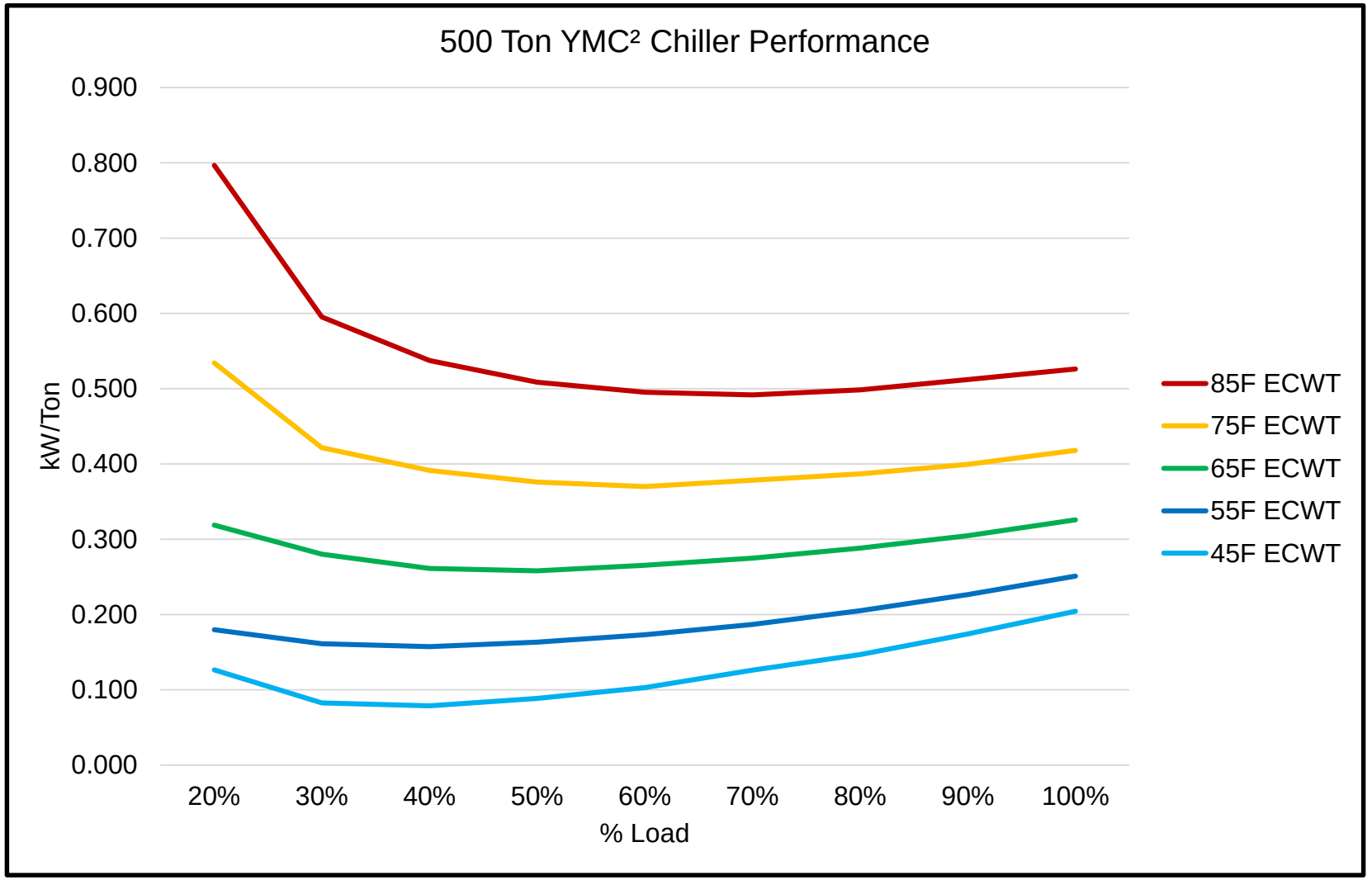
Energy Usage Based on Lift and Load



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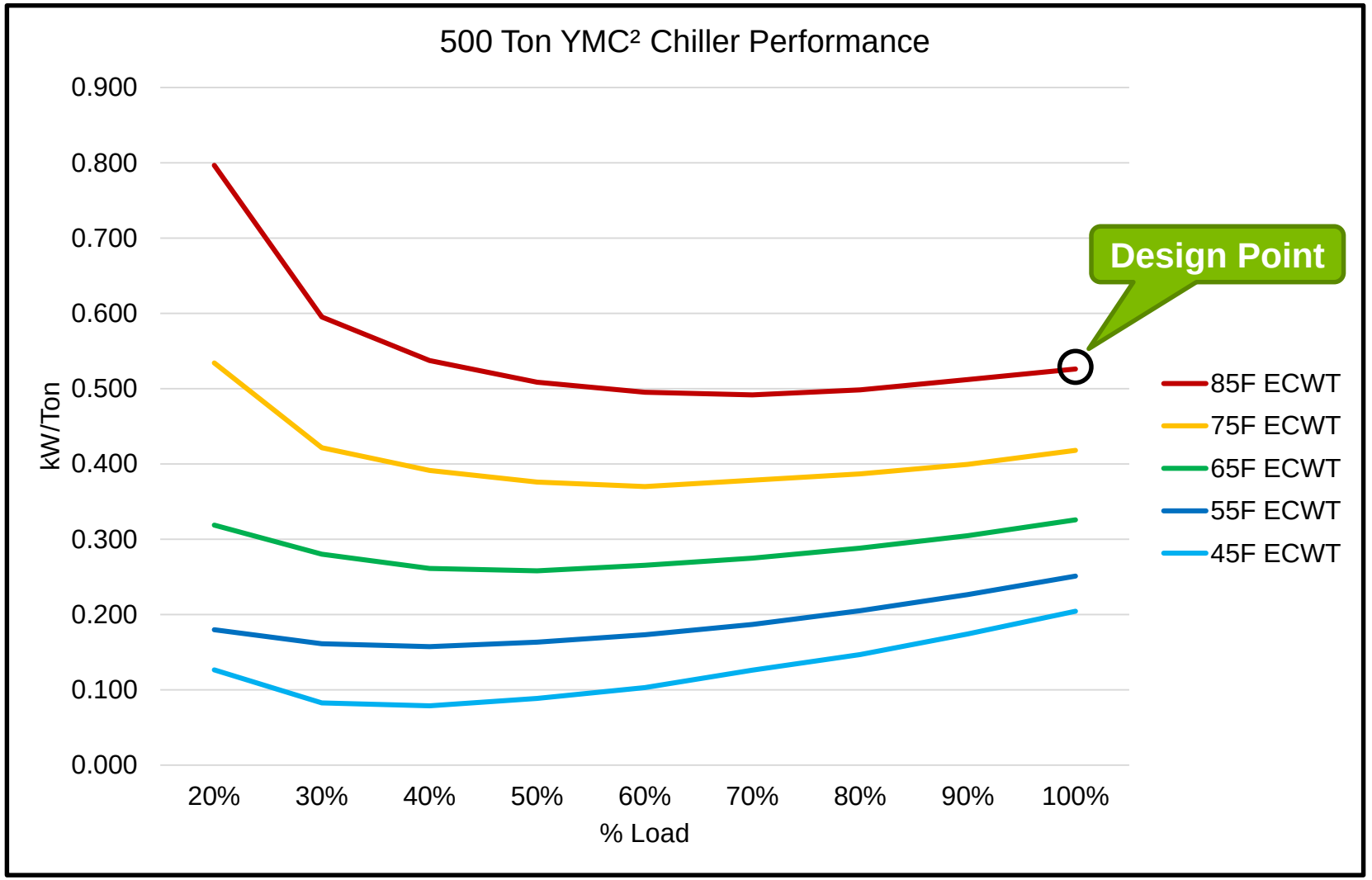

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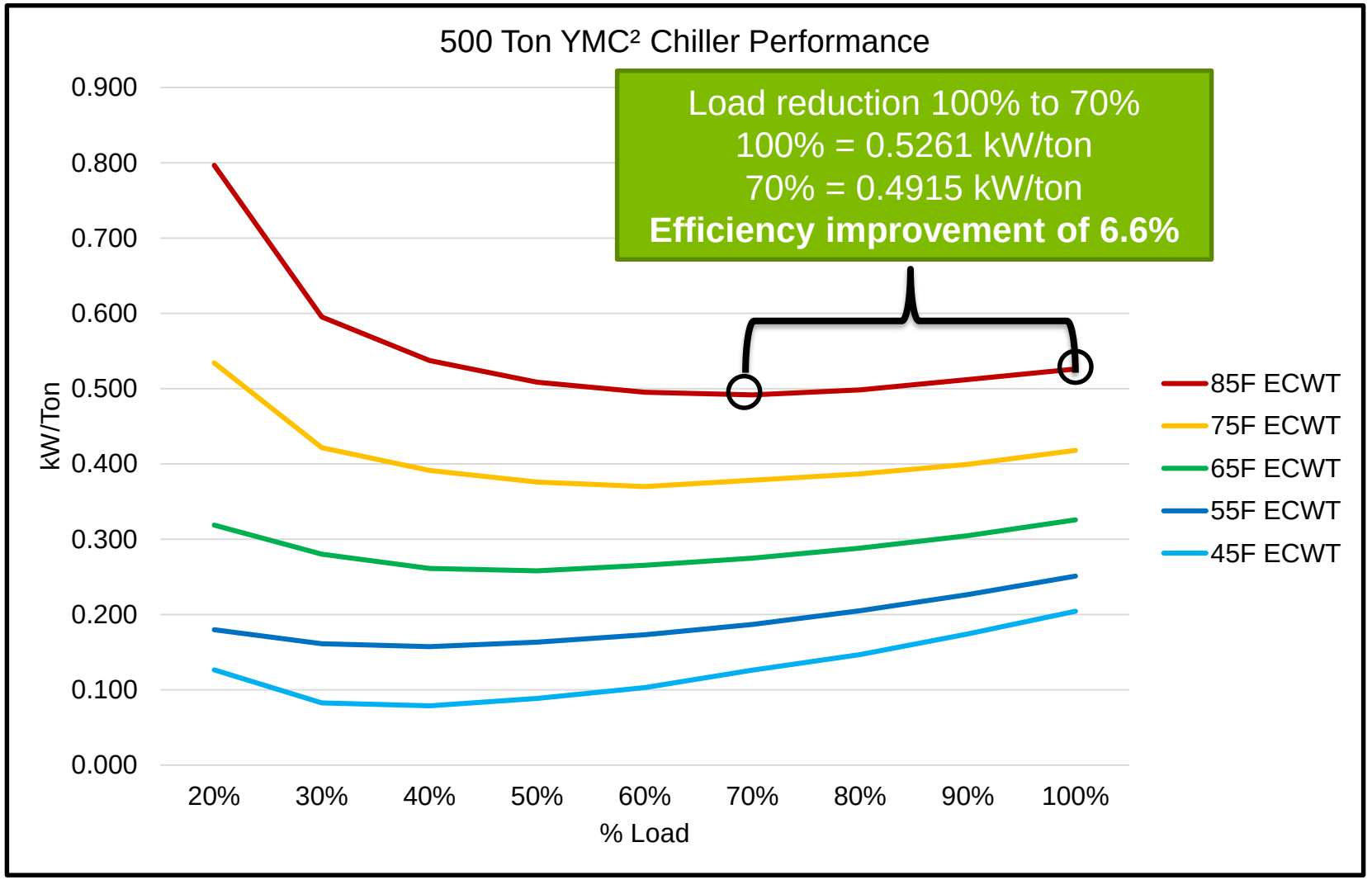
Energy Usage Based on Lift and Load



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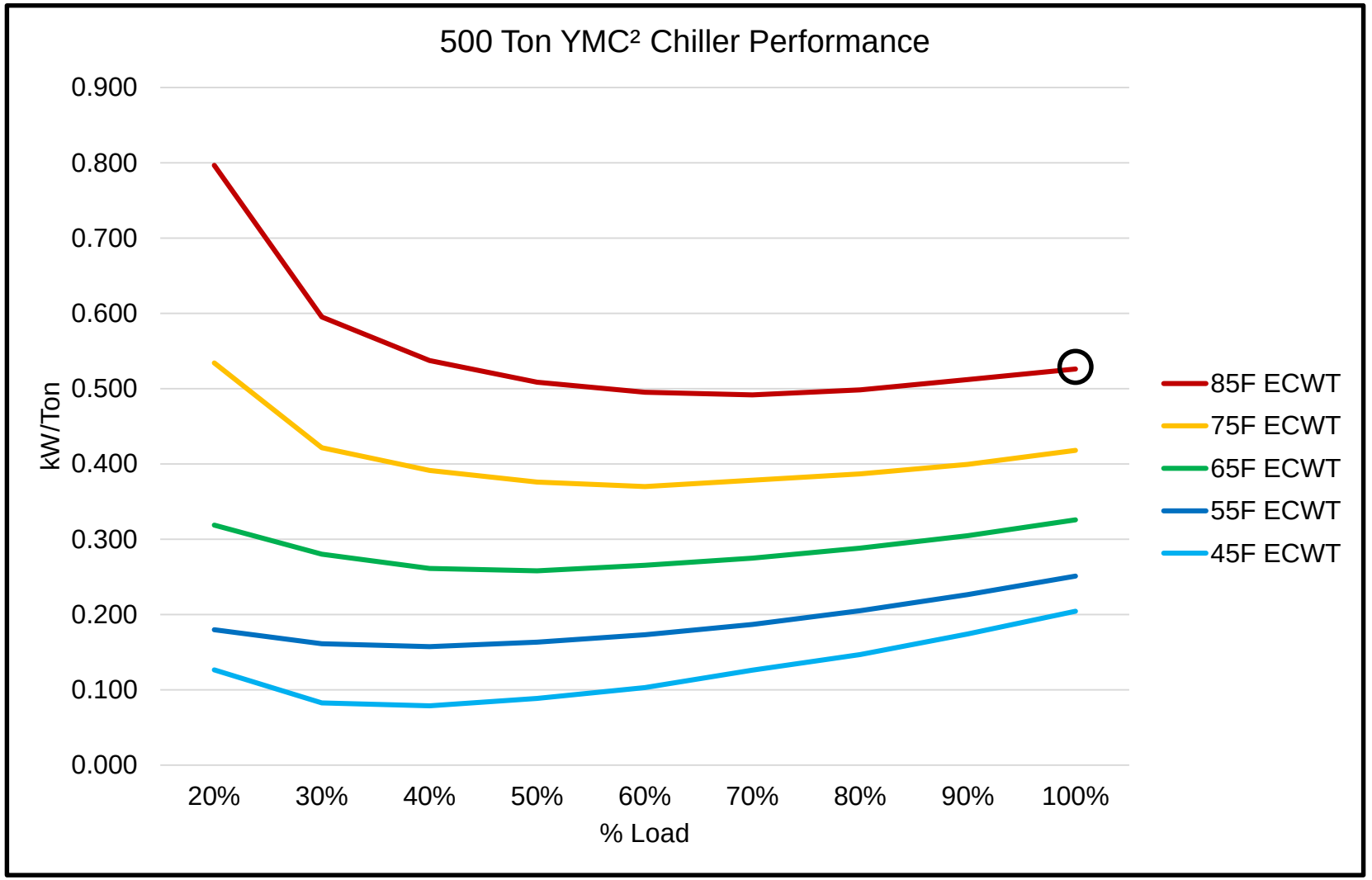
Energy Usage Based on Lift and Load

Load reduction 100% to 70%
100% = 0.5261 kW/ton
70% = 0.4915 kW/ton
Efficiency improvement of 6.6%



Johnson Controls

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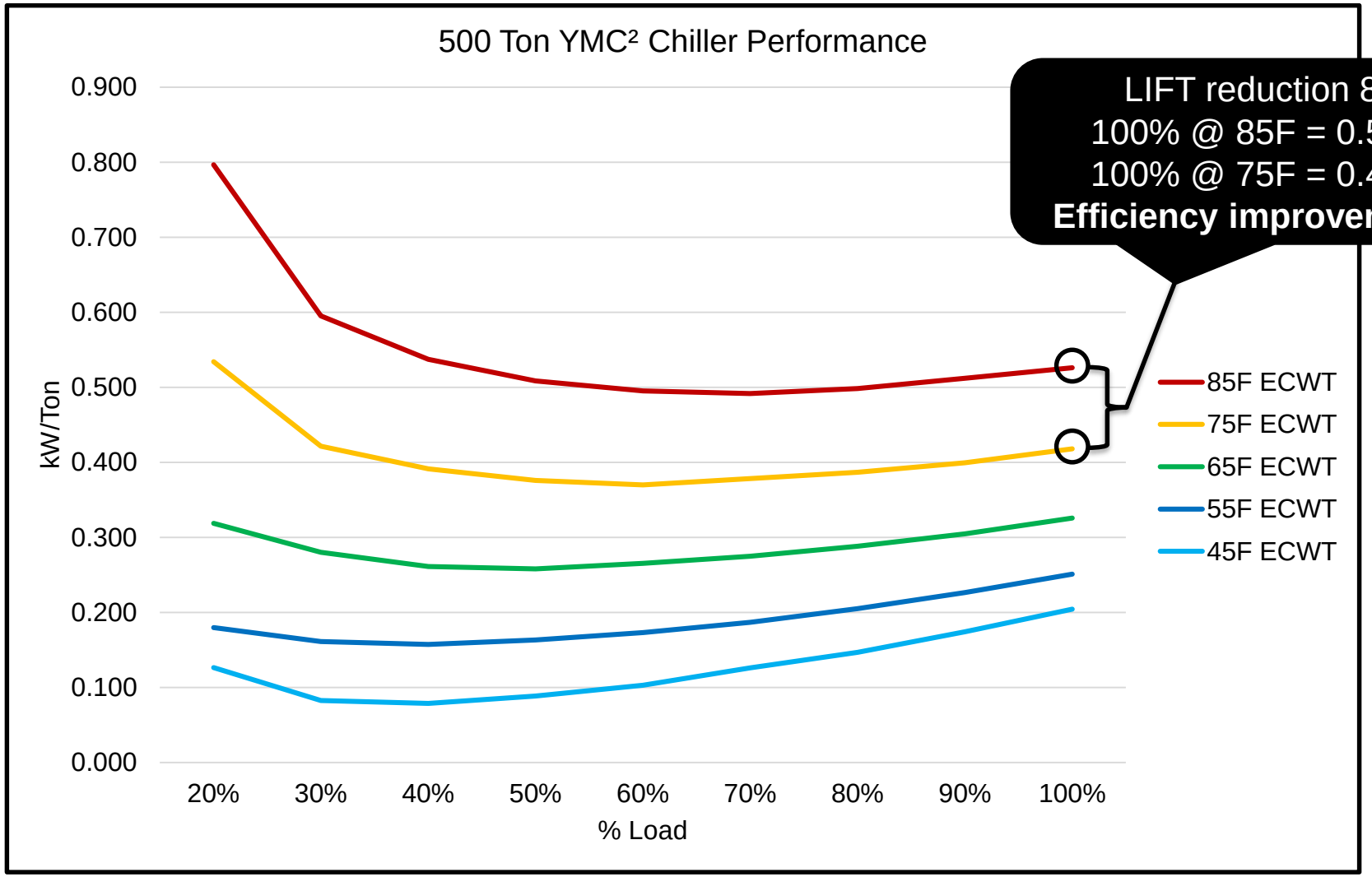

LIFT reduction 85F to 75F
100% @ 85F = 0.5261 kW/ton
100% @ 75F = 0.4179 kW/ton
Efficiency improvement of 20.5%

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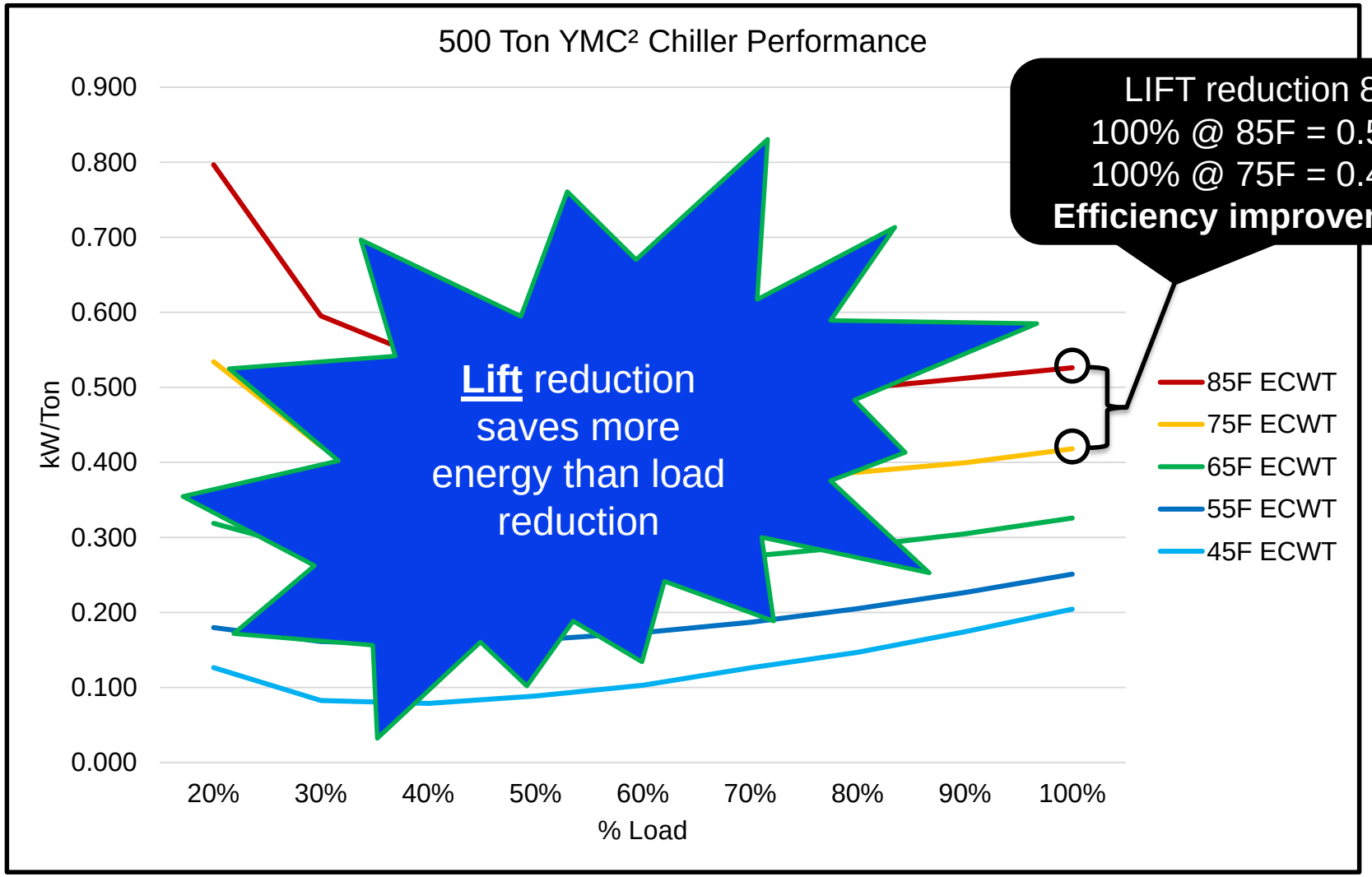
Energy Usage Based on Lift and Load

Load reduction 100% to 70%
100% = 0.5261 kW/ton
70% = 0.4915 kW/ton
Efficiency improvement of 6.6%



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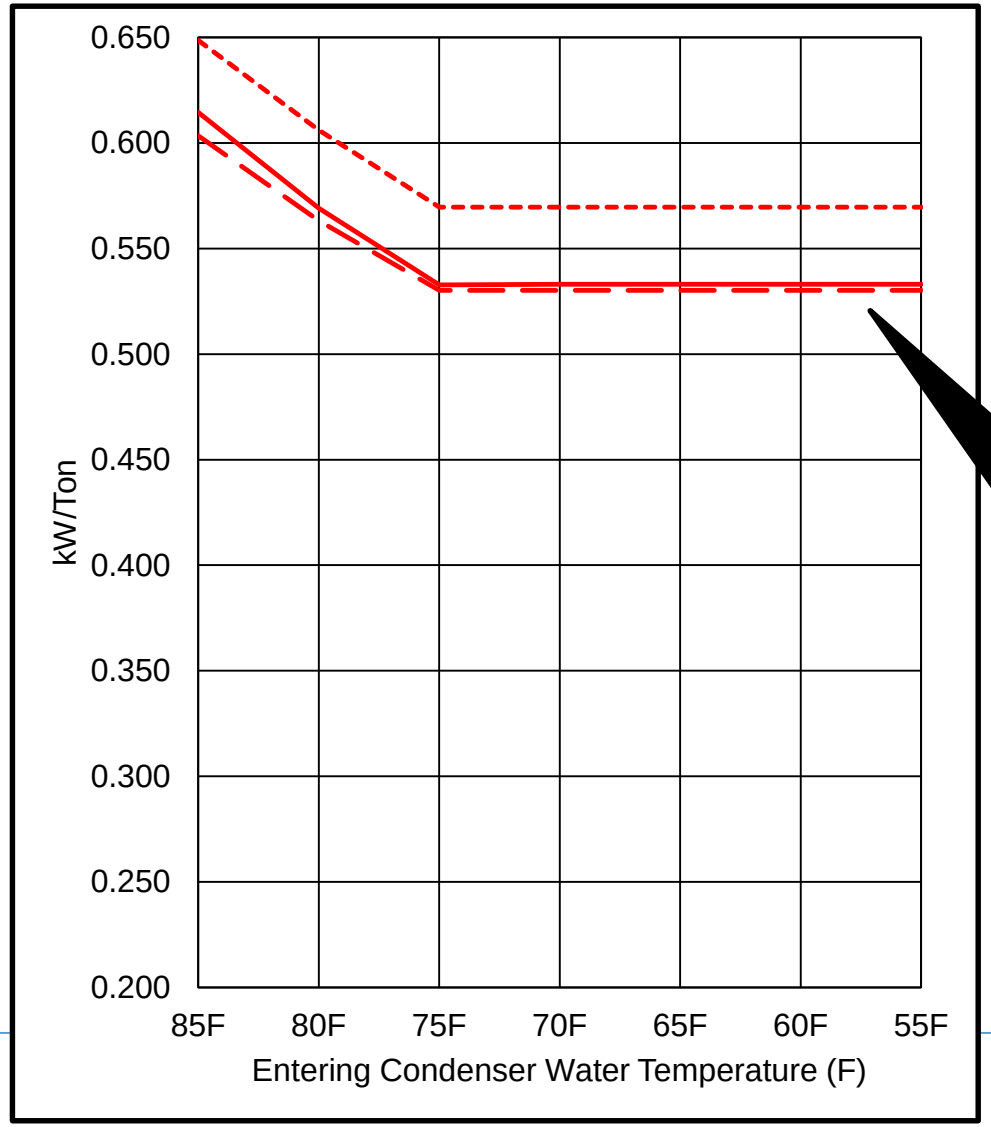
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



Traditional – Constant Speed w/ Fixed Orifice

50% Load – – – – – –
100% Load ————
80% Load — —

"Flat Line" caused by the use of Head Pressure Control (HPC) systems

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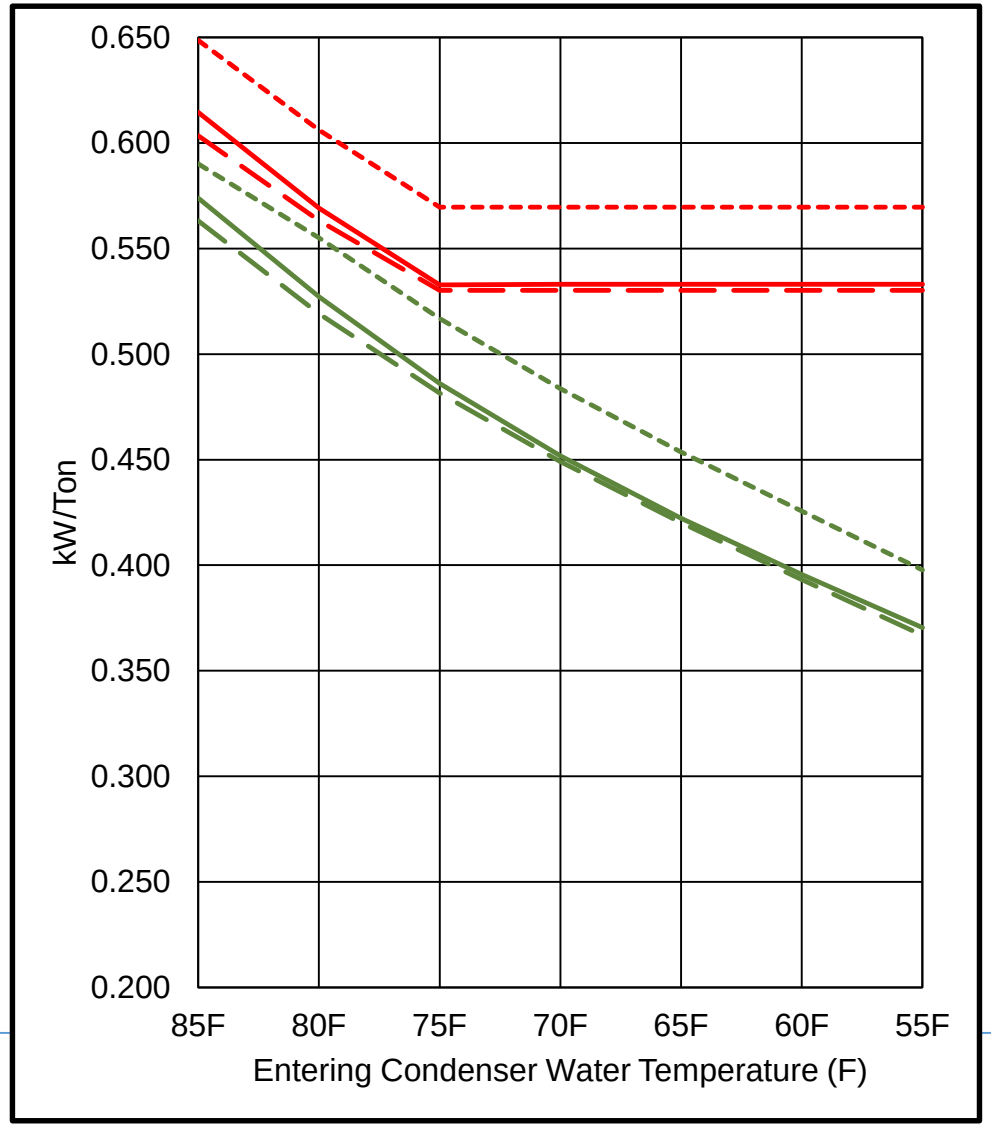
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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100% Load ————
80% Load —— ——

New - Constant Speed w/ Variable Orifice

50% Load – – – – – –
100% Load ————
80% Load —— ——

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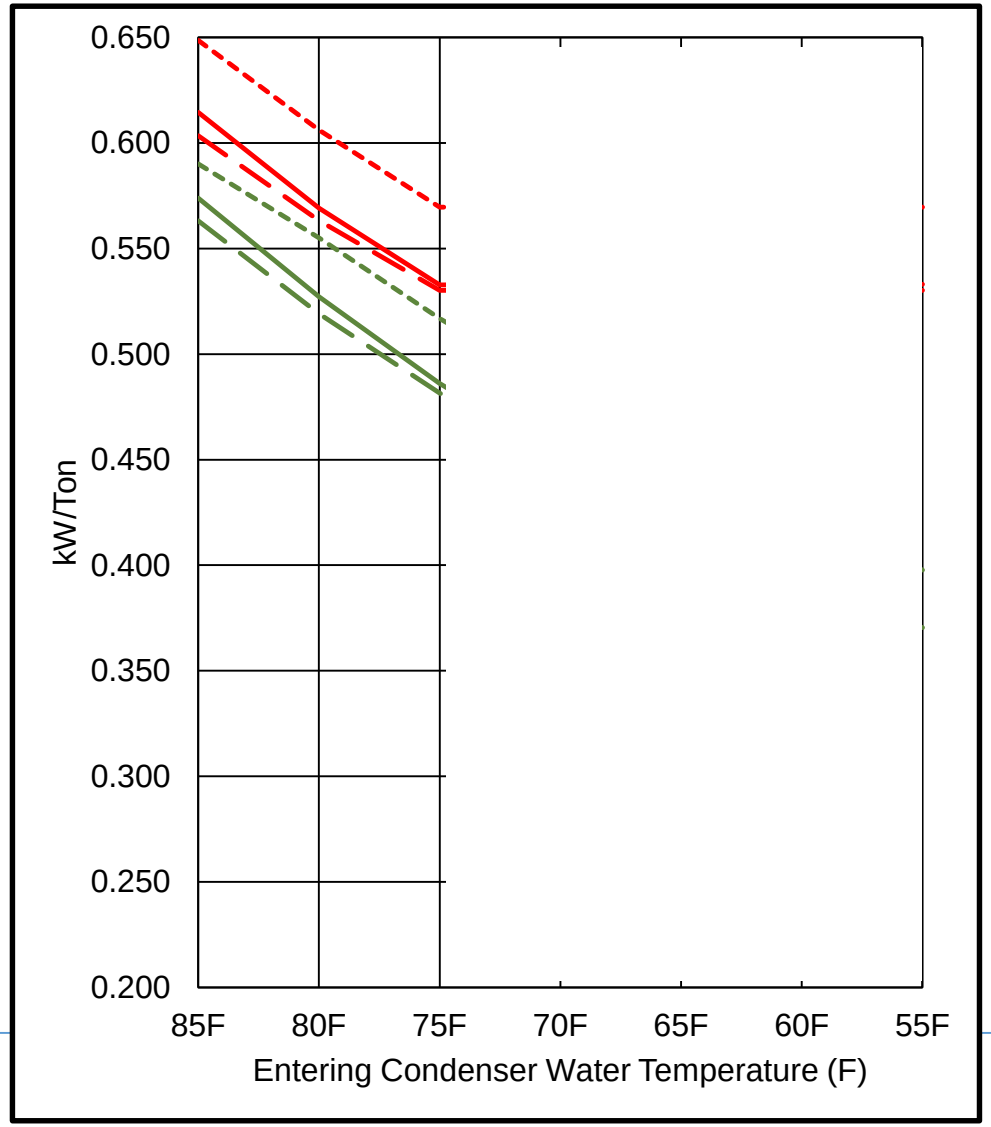
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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New - Constant Speed w/ Variable Orifice

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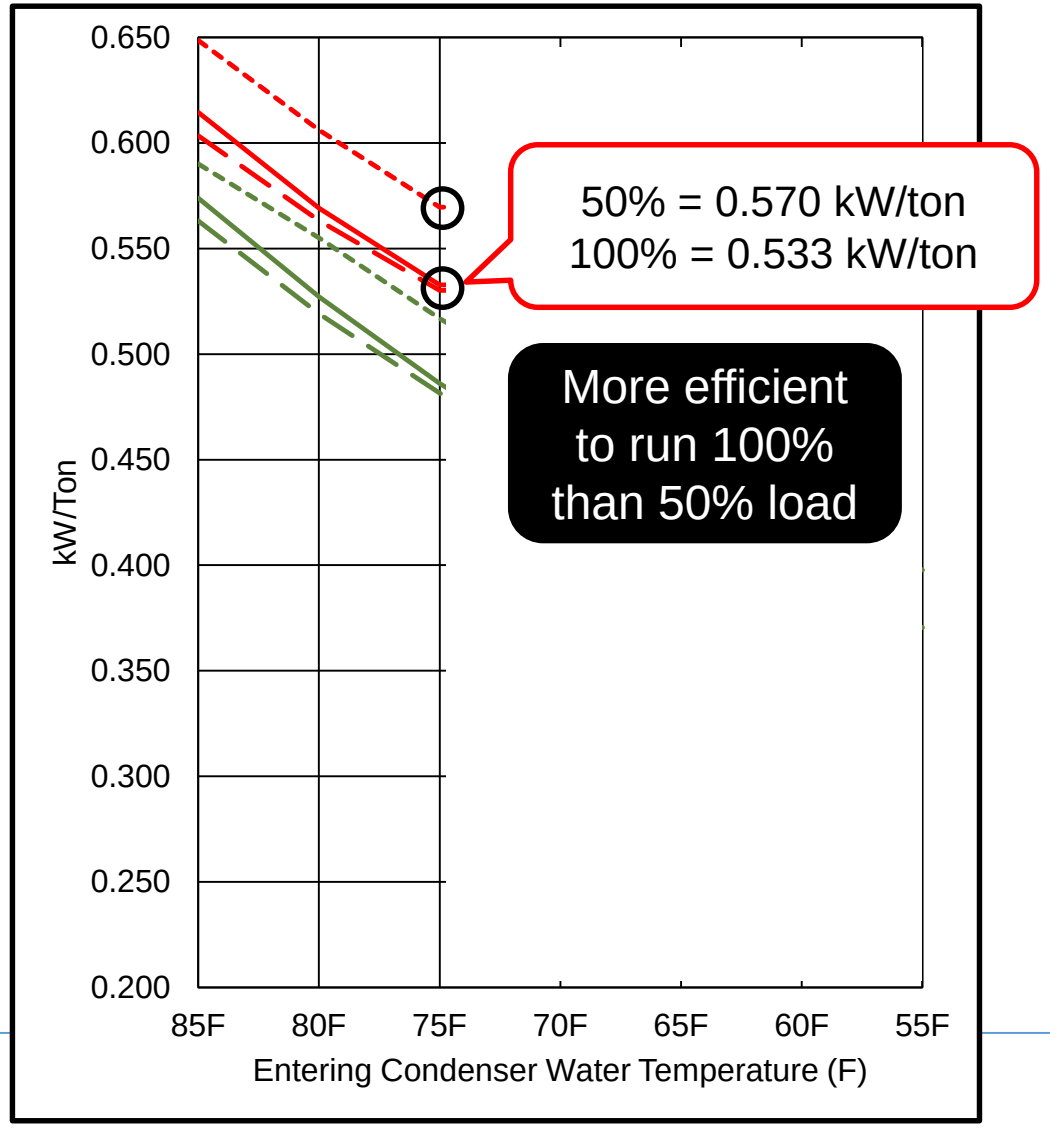
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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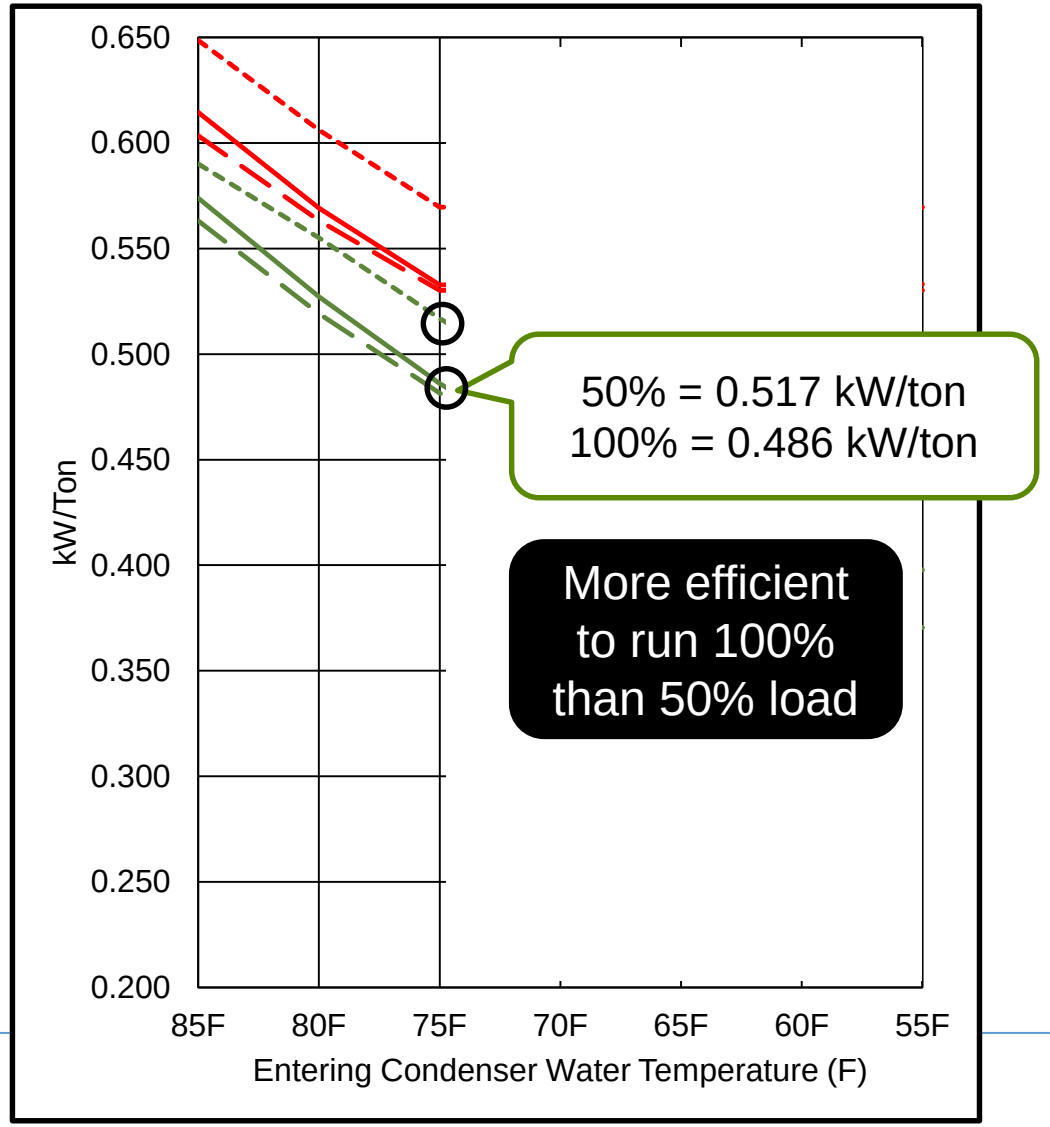
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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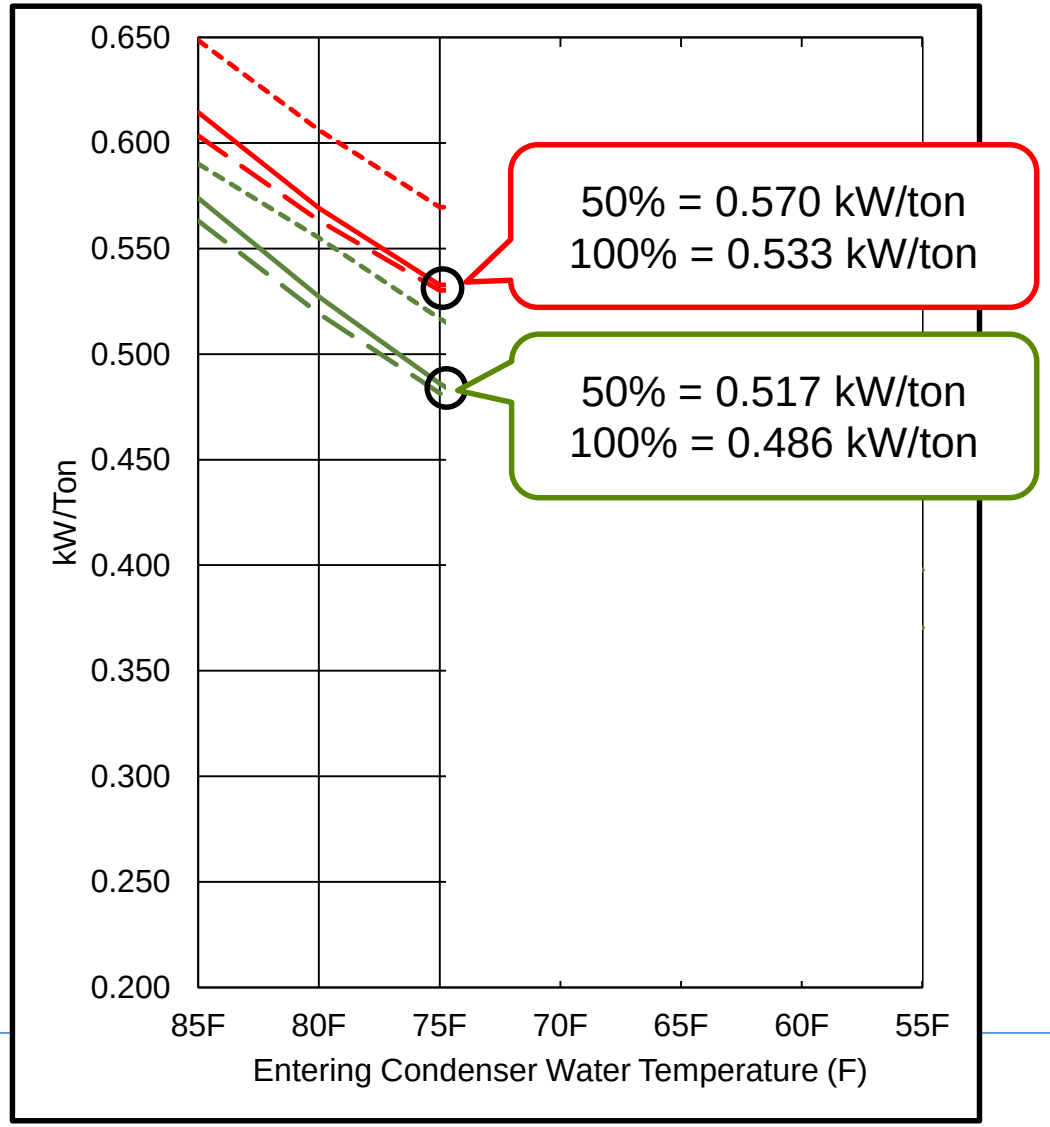
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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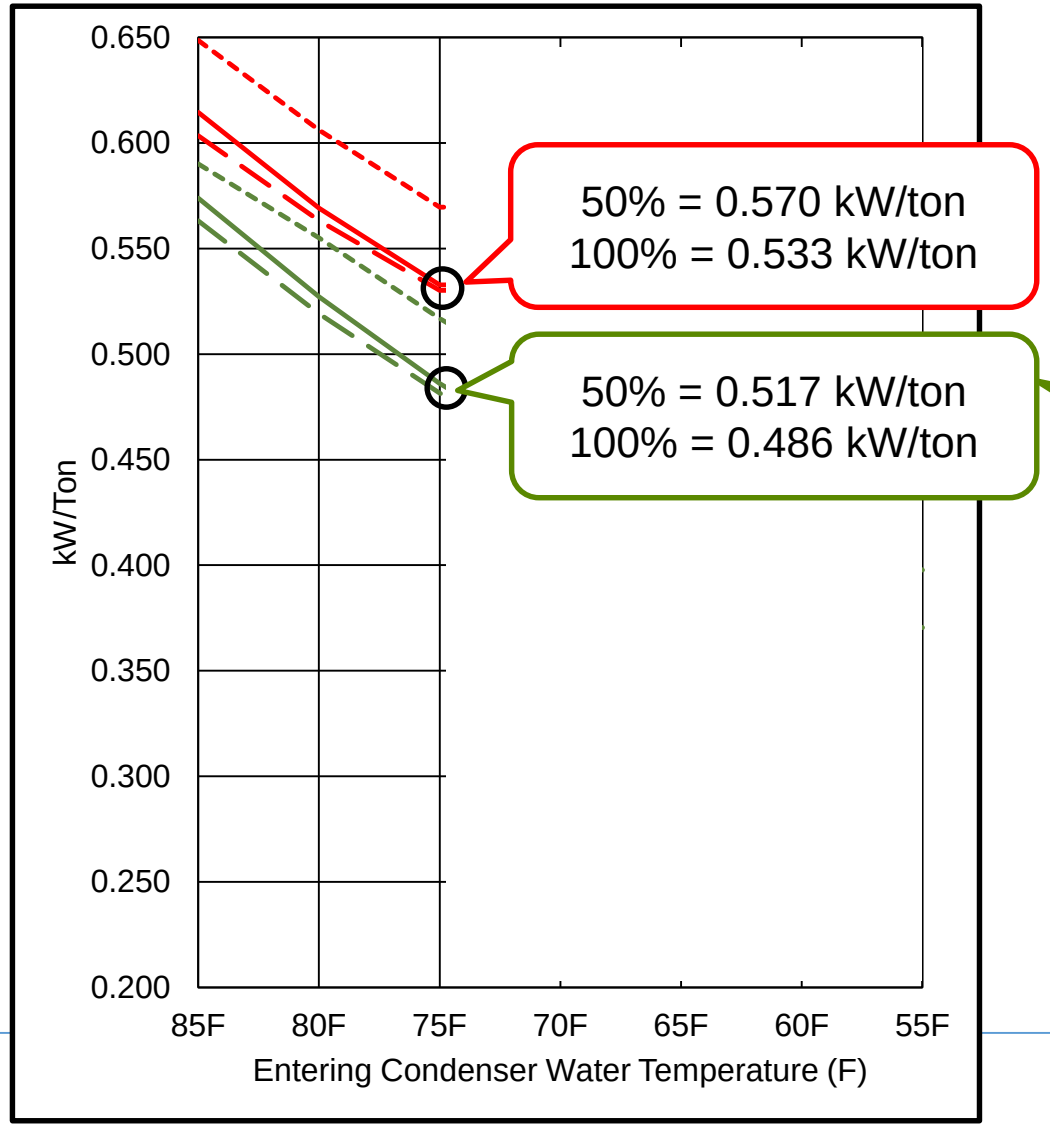
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



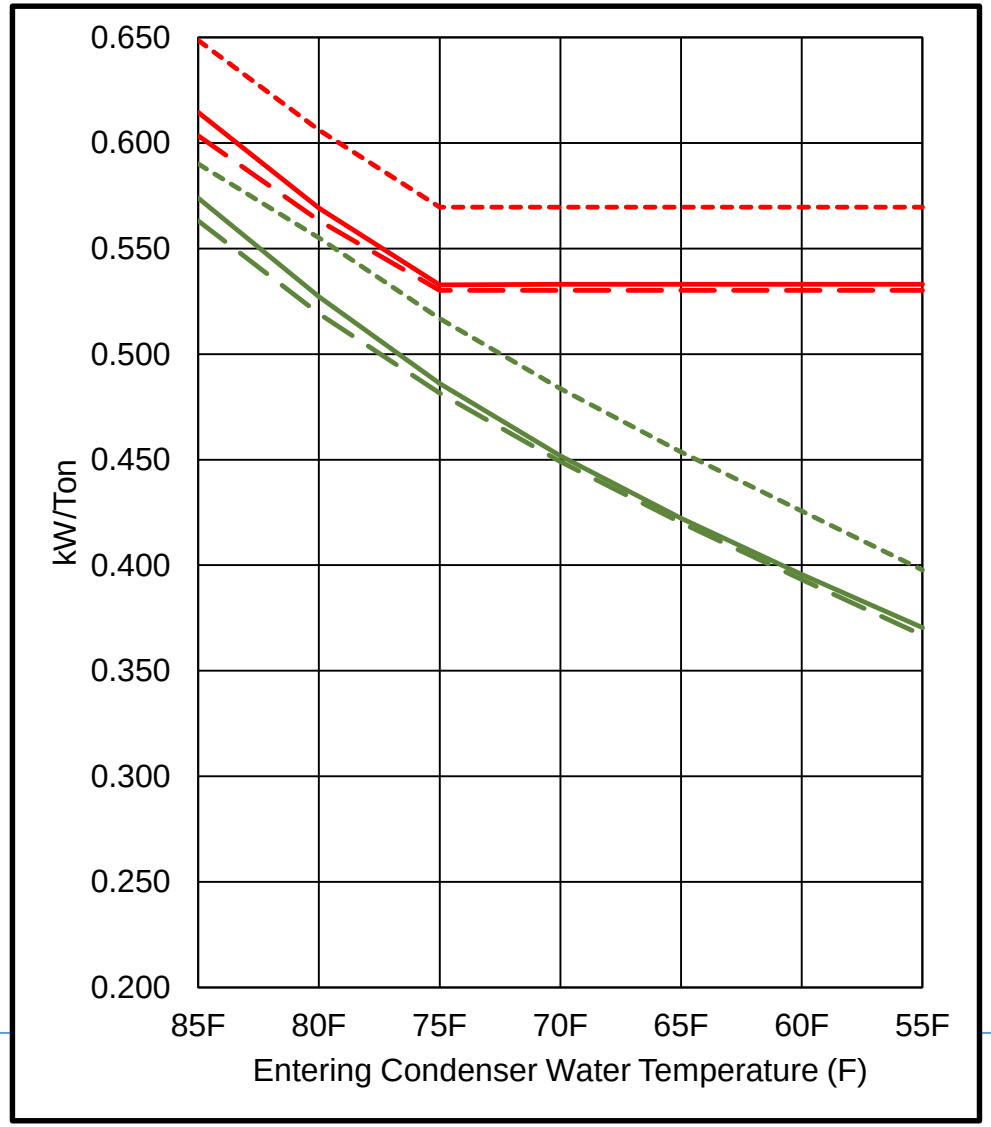
Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

Assume 500ton chiller
50% load - difference of 13.25kW
100% load - difference of 23.5kW

Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



Traditional – Constant Speed w/ Fixed Orifice

50% Load – – – – – –
100% Load ————
80% Load —— ——

New - Constant Speed w/ Variable Orifice

50% Load – – – – – –
100% Load ————
80% Load —— ——

More efficient to run 100% than 50% load

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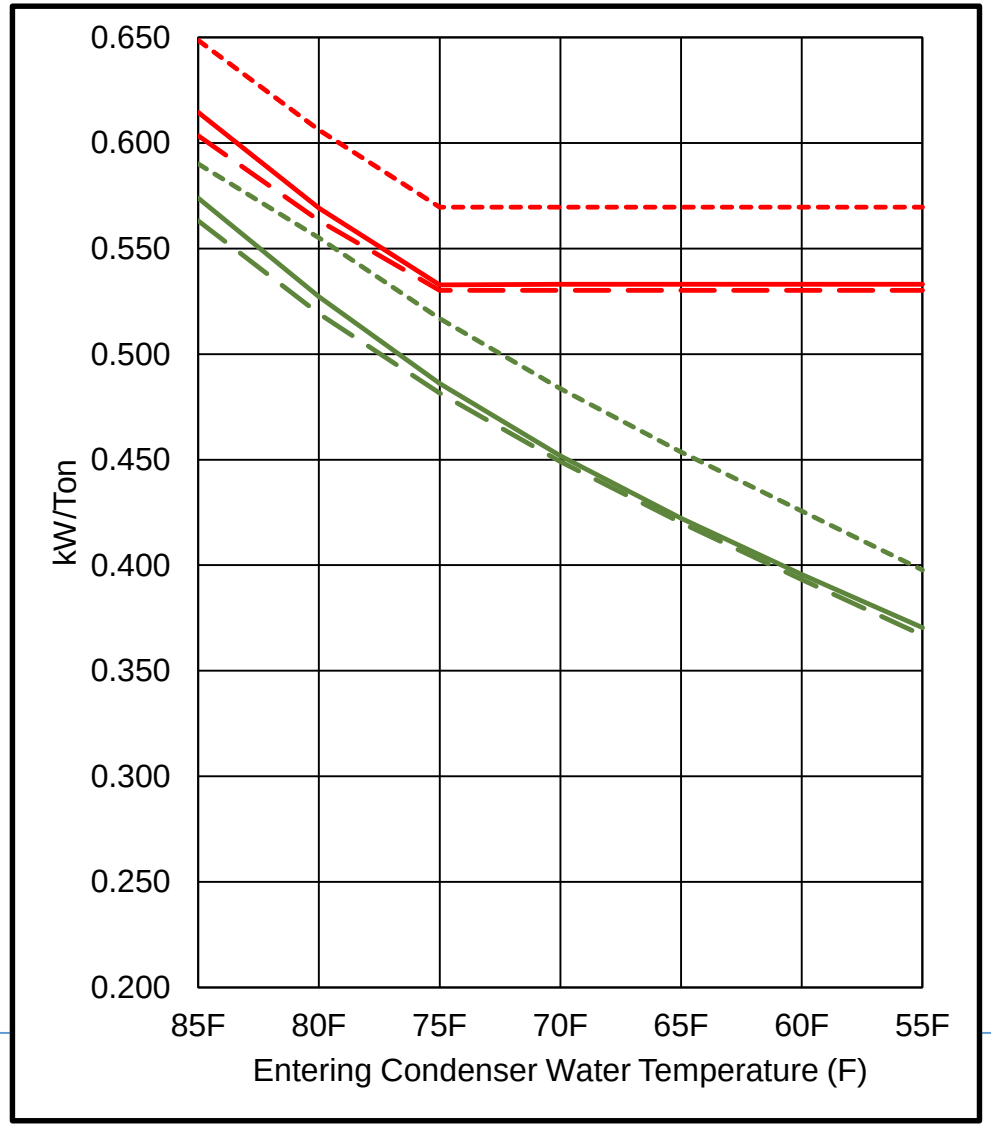
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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New - Constant Speed w/ Variable Orifice

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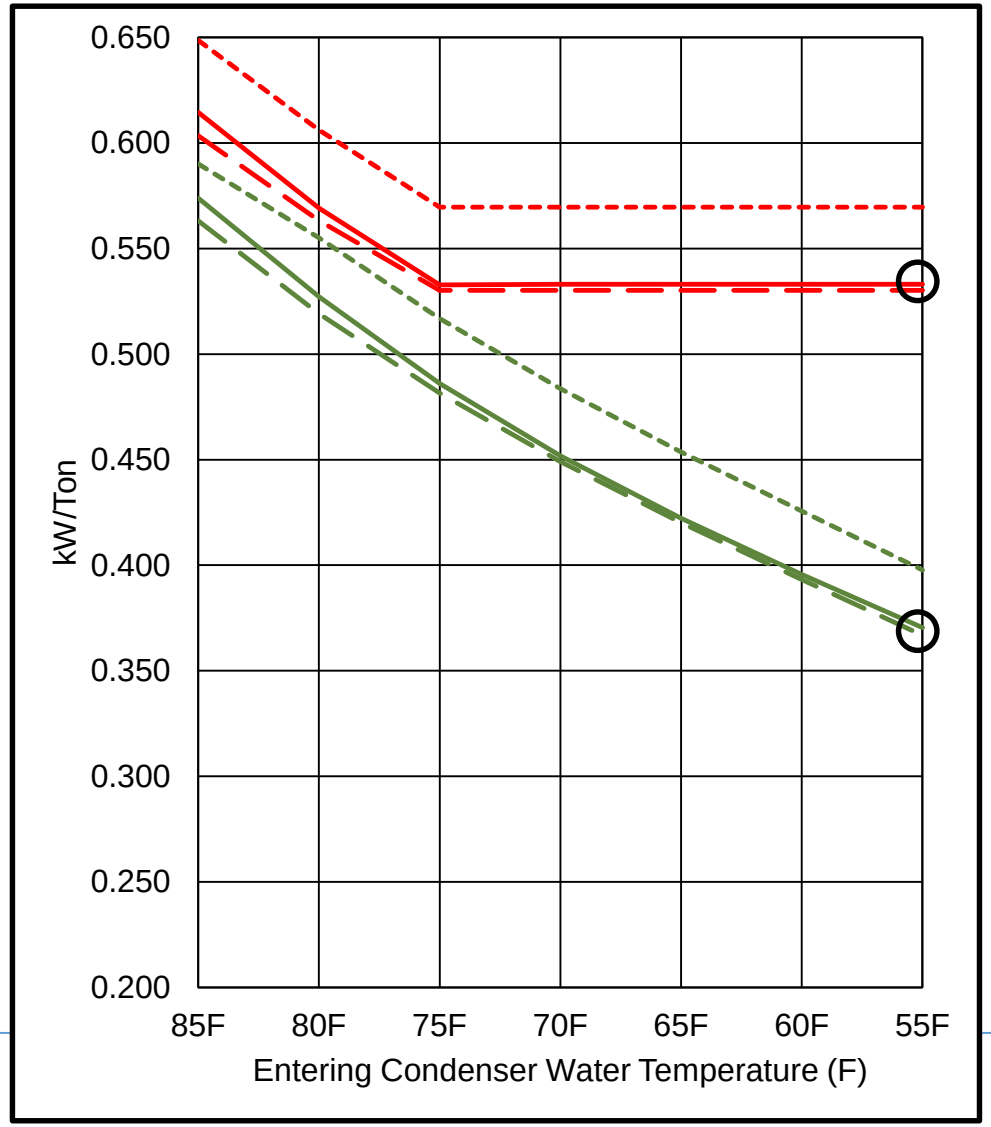
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



Traditional – Constant Speed w/ Fixed Orifice

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100% Load ————
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New - Constant Speed w/ Variable Orifice

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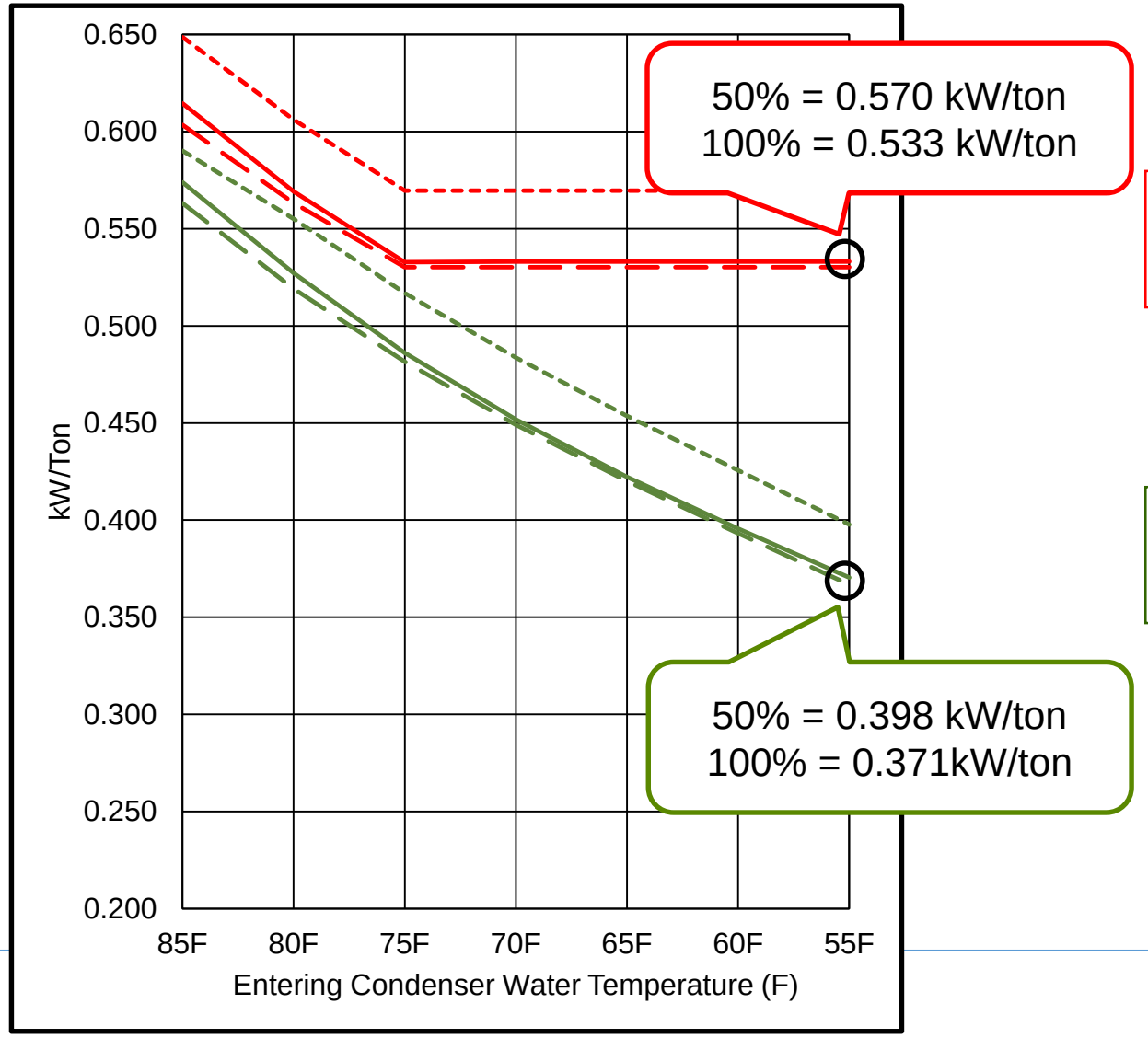
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



Traditional – Constant Speed w/ Fixed Orifice

50% Load
100% Load
80% Load

New - Constant Speed w/ Variable Orifice

50% Load
100% Load
80% Load

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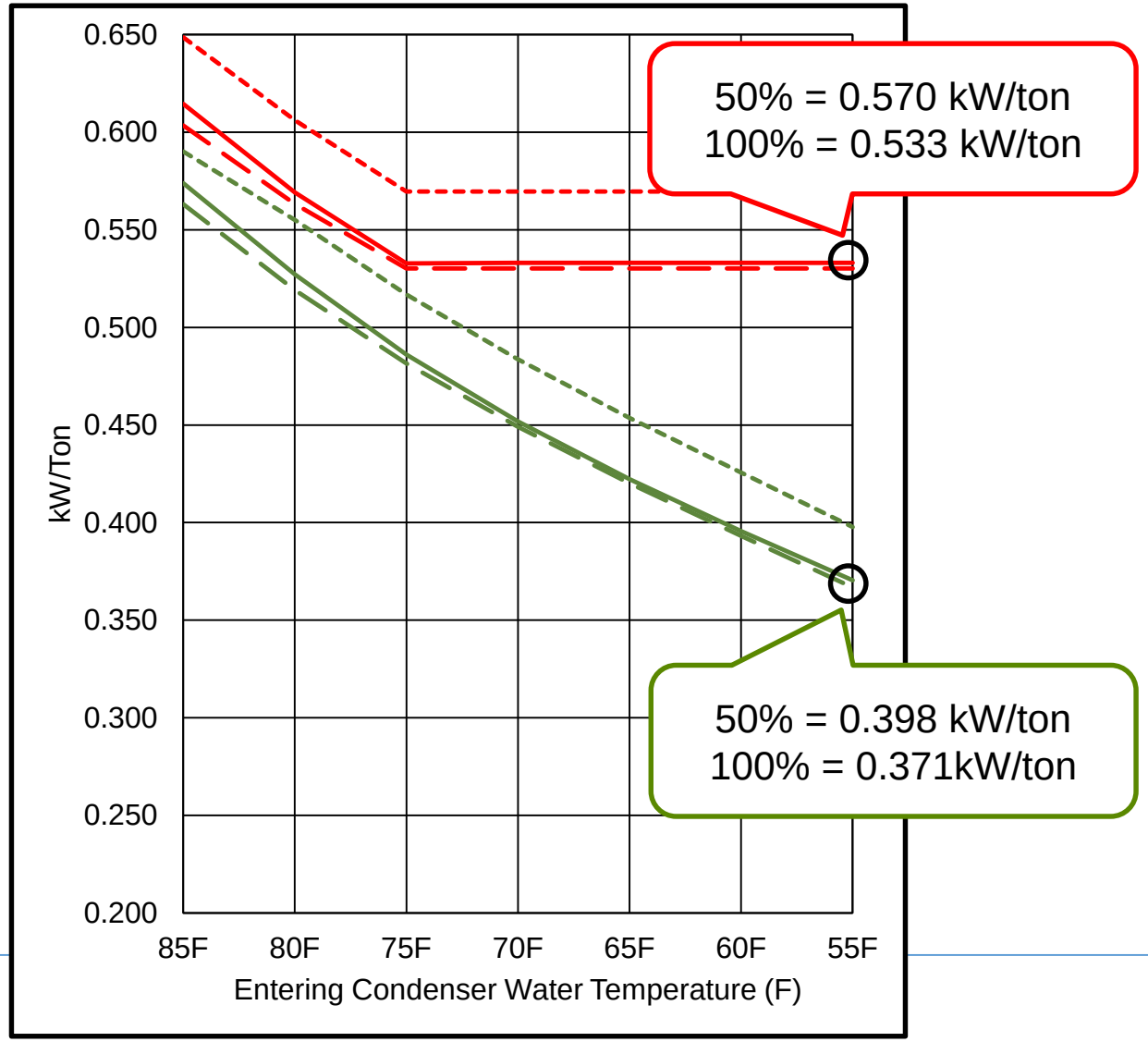
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



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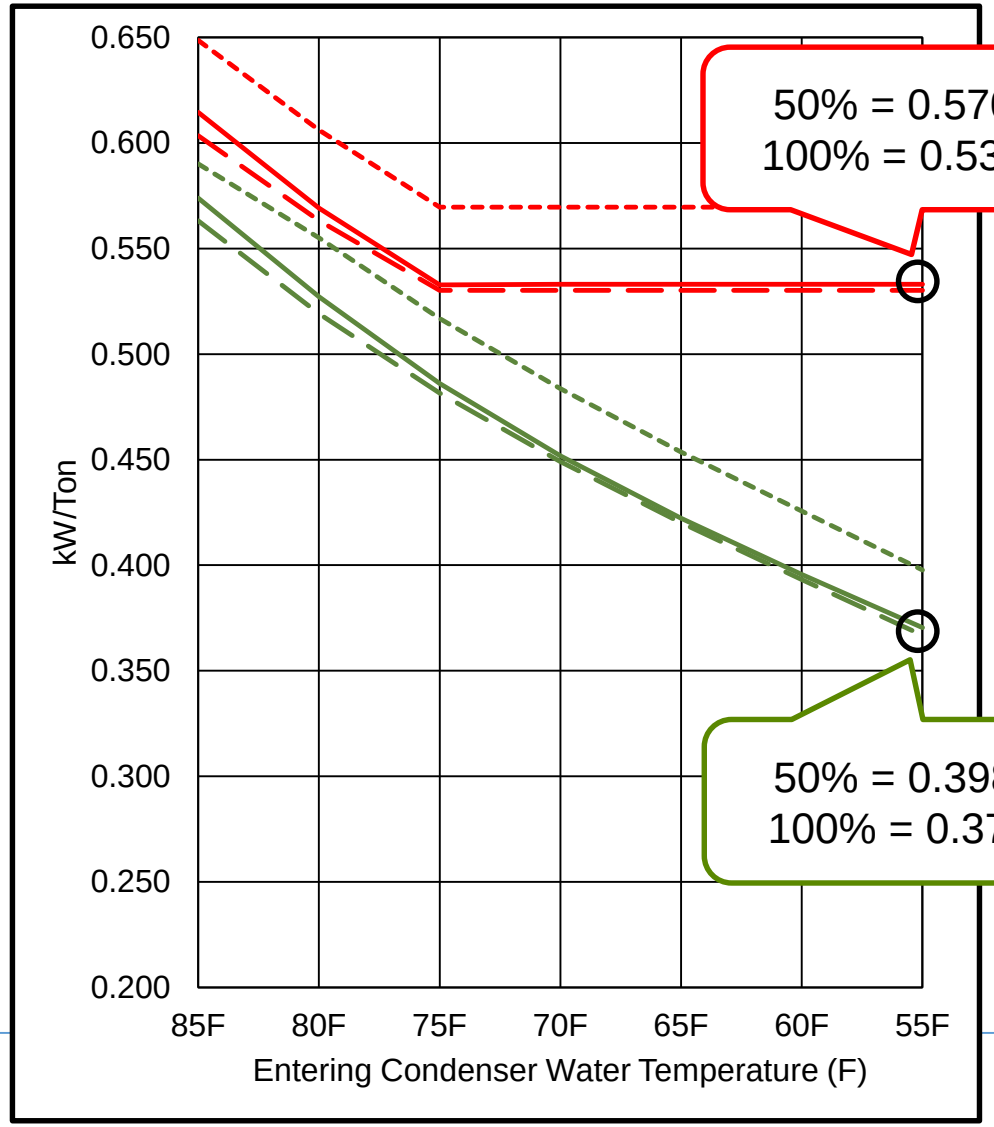
Real World Energy Performance

Capitalizing on Part Load Conditions -ECWT vs kW/ton



50% = 0.570 kW/ton
100% = 0.533 kW/ton

Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

50% = 0.398 kW/ton
100% = 0.371kW/ton

Assume 500ton chiller
50% load - difference of 43kW
100% load - difference of 81kW

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Real World Energy Performance

Employing Variable Speed Technology to Maximize Efficiency

- Taking advantage of real world conditions

  As weather conditions and building load change, design conditions exist only 1% of the operating hours

- Applying VSD to chillers reduces energy consumption by 30%
- Globally commissioned over 50,000 VSD
- **EPA's Prestigious Climate Protection Award**

  YORK VSD chillers save 600,000 tons of CO_2 emissions annually

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Real World Energy Performance

Fixed Speed vs Variable Speed

Comparison at AHRI conditions

% Load	ECWT
100	85.0
90	81.0
80	77.0
70	73.0
60	69.0
50	65.0
40	65.0
30	65.0
20	65.0
15	65.0

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Real World Energy Performance

Fixed Speed vs Variable Speed

Comparison at AHRI conditions

% Load	ECWT
100	85.0
90	81.0
80	77.0
70	73.0
60	69.0
50	65.0
40	65.0
30	65.0
20	65.0
15	65.0

AHRI standards limit the tower water to 65F Entering Condenser Water Temperature (ECWT)

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Real World Energy Performance

Fixed Speed vs Variable Speed

Comparison at AHRI conditions

		No VSD	VSD
% Load	ECWT	KW/TON	KW/TON
100	85.0	0.5737	0.5823
90	81.0	0.5284	0.5147
80	77.0	0.4958	0.4512
70	73.0	0.4730	0.3900
60	69.0	0.4589	0.3367
50	65.0	0.4536	0.2876
40	65.0	0.4870	0.2914
30	65.0	0.5429	0.3284
20	65.0	0.6575	0.3777
15	65.0	0.7639	0.4357

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Real World Energy Performance

Fixed Speed vs Variable Speed

Comparison at AHRI conditions

		No VSD	VSD	
% Load	ECWT	KW/TON	KW/TON	%SAVED
100	85.0	0.5737	0.5823	-1.49
90	81.0	0.5284	0.5147	2.59
80	77.0	0.4958	0.4512	9.00
70	73.0	0.4730	0.3900	17.55
60	69.0	0.4589	0.3367	26.63
50	65.0	0.4536	0.2876	36.60
40	65.0	0.4870	0.2914	40.16
30	65.0	0.5429	0.3284	39.51
20	65.0	0.6575	0.3777	42.56
15	65.0	0.7639	0.4357	42.96

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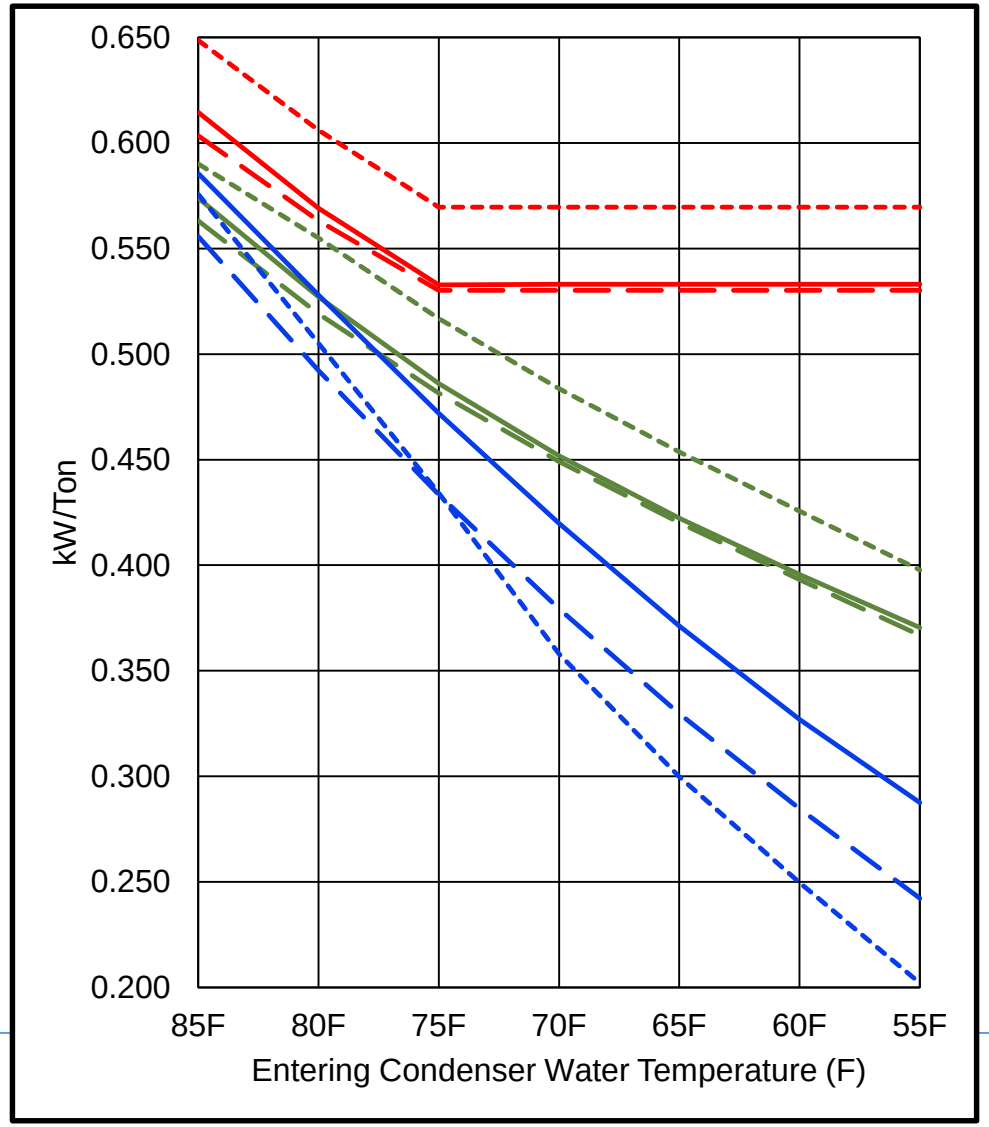
Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

- 50% Load
- 100% Load
- 80% Load

New - Constant Speed w/ Variable Orifice

- 50% Load
- 100% Load
- 80% Load

Variable Speed w/ Variable Orifice

- 100% Load
- 80% Load
- 50% Load

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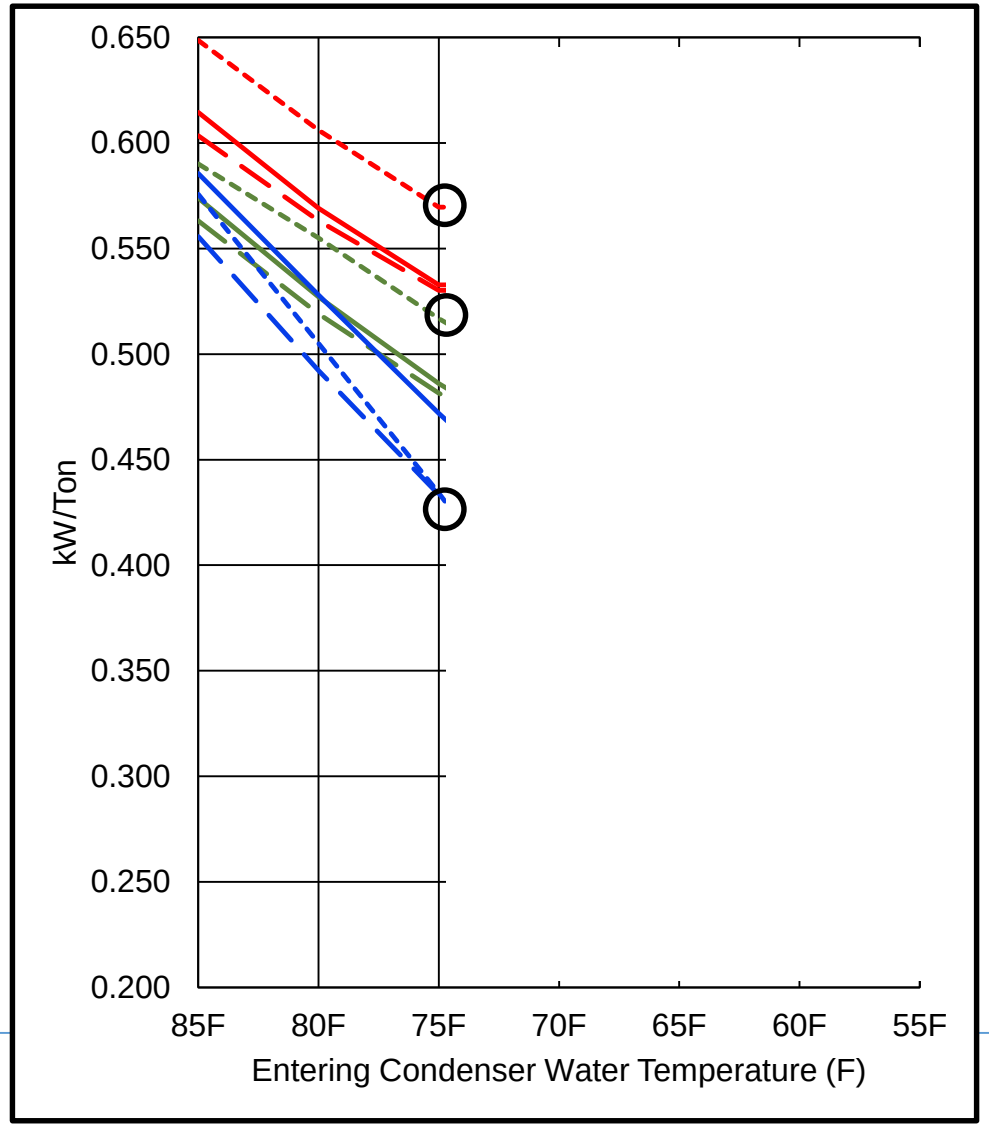
Real World Energy Performance

Fixed Speed vs Variable Speed



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50% Load – – – – – –
100% Load ————
80% Load — —

New - Constant Speed w/ Variable Orifice

50% Load – – – – – –
100% Load ————
80% Load — —

Variable Speed w/ Variable Orifice

100% Load ————
80% Load — —
50% Load – – – – – –

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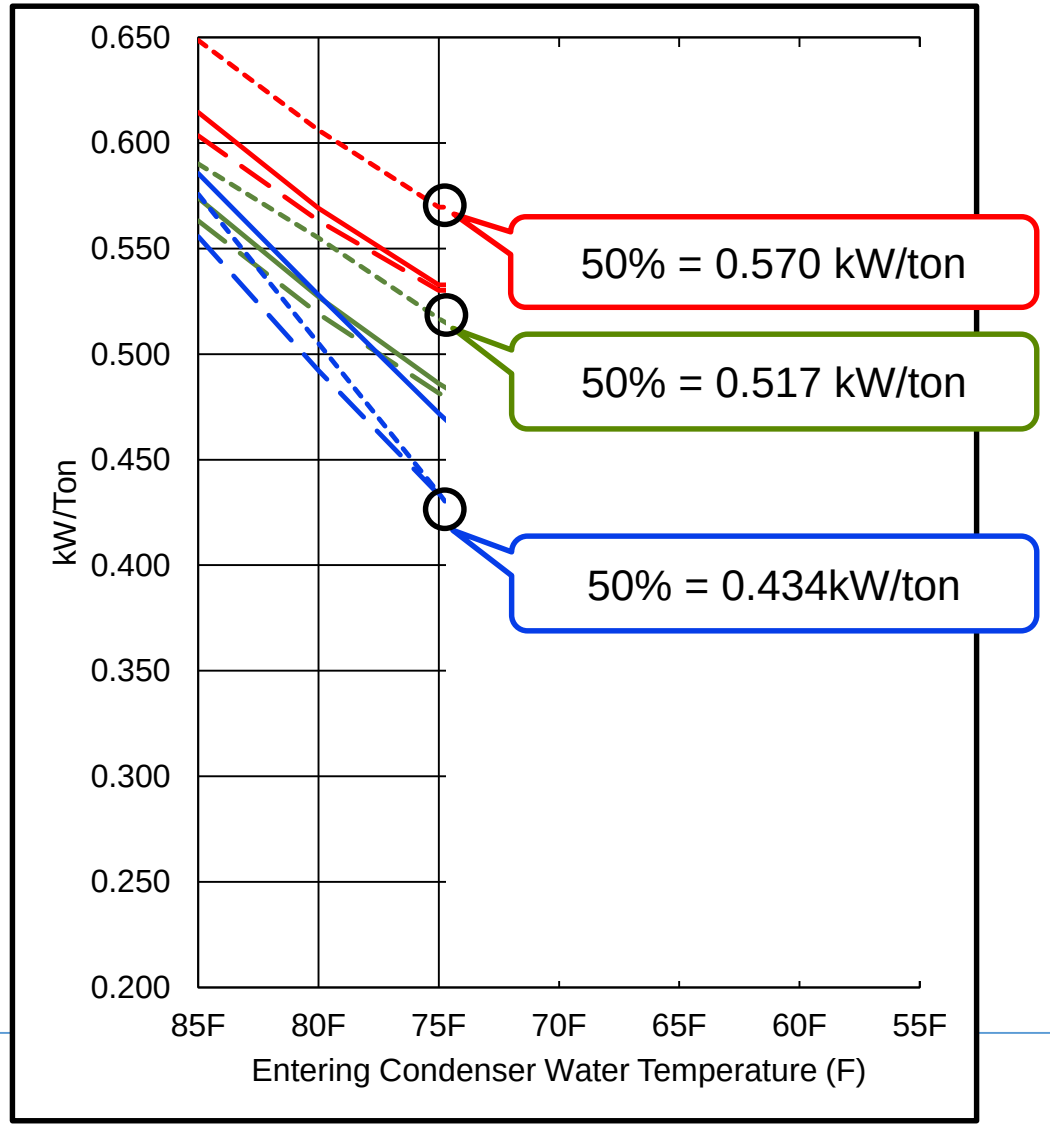
Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

- 50% Load
- 100% Load
- 80% Load

New - Constant Speed w/ Variable Orifice

- 50% Load
- 100% Load
- 80% Load

Variable Speed w/ Variable Orifice

- 100% Load
- 80% Load
- 50% Load

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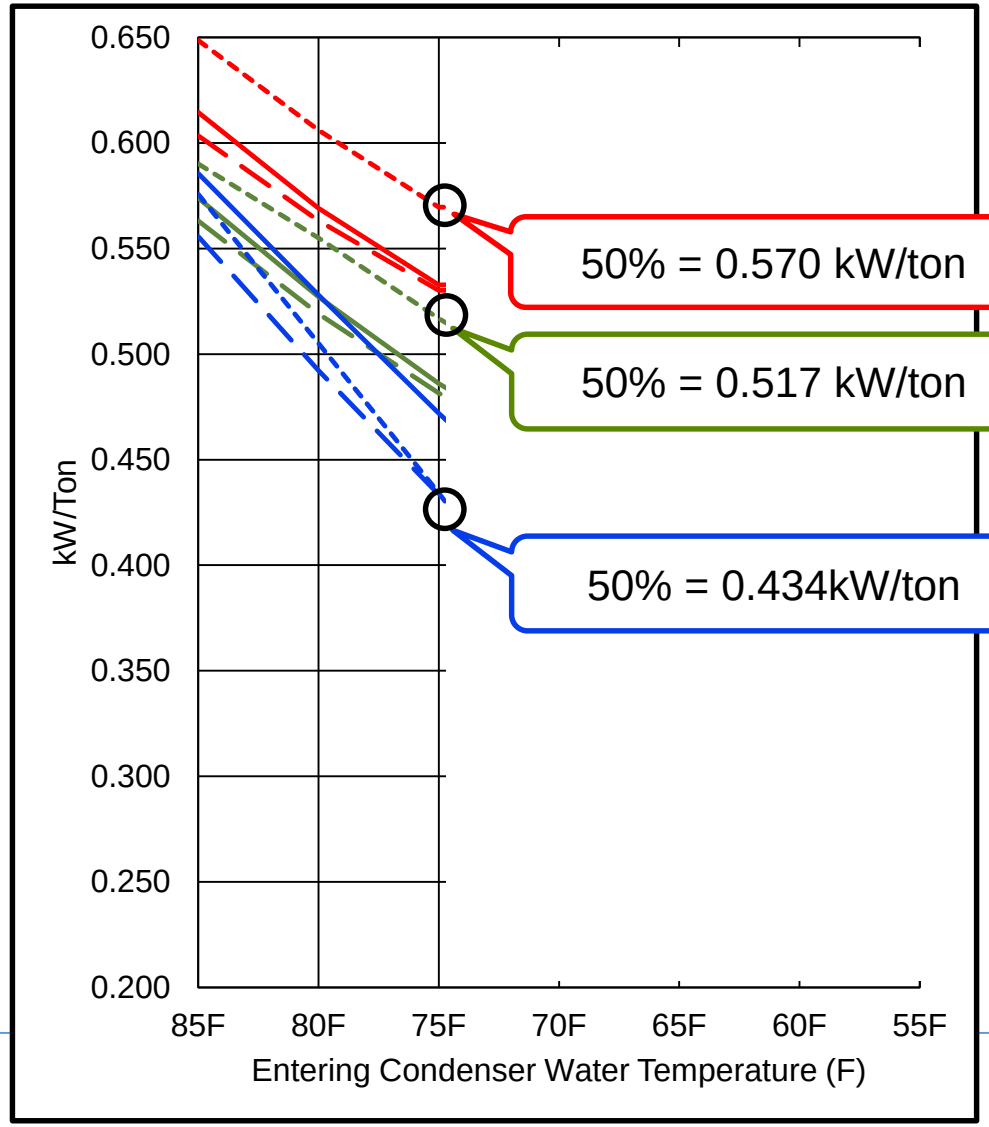
Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

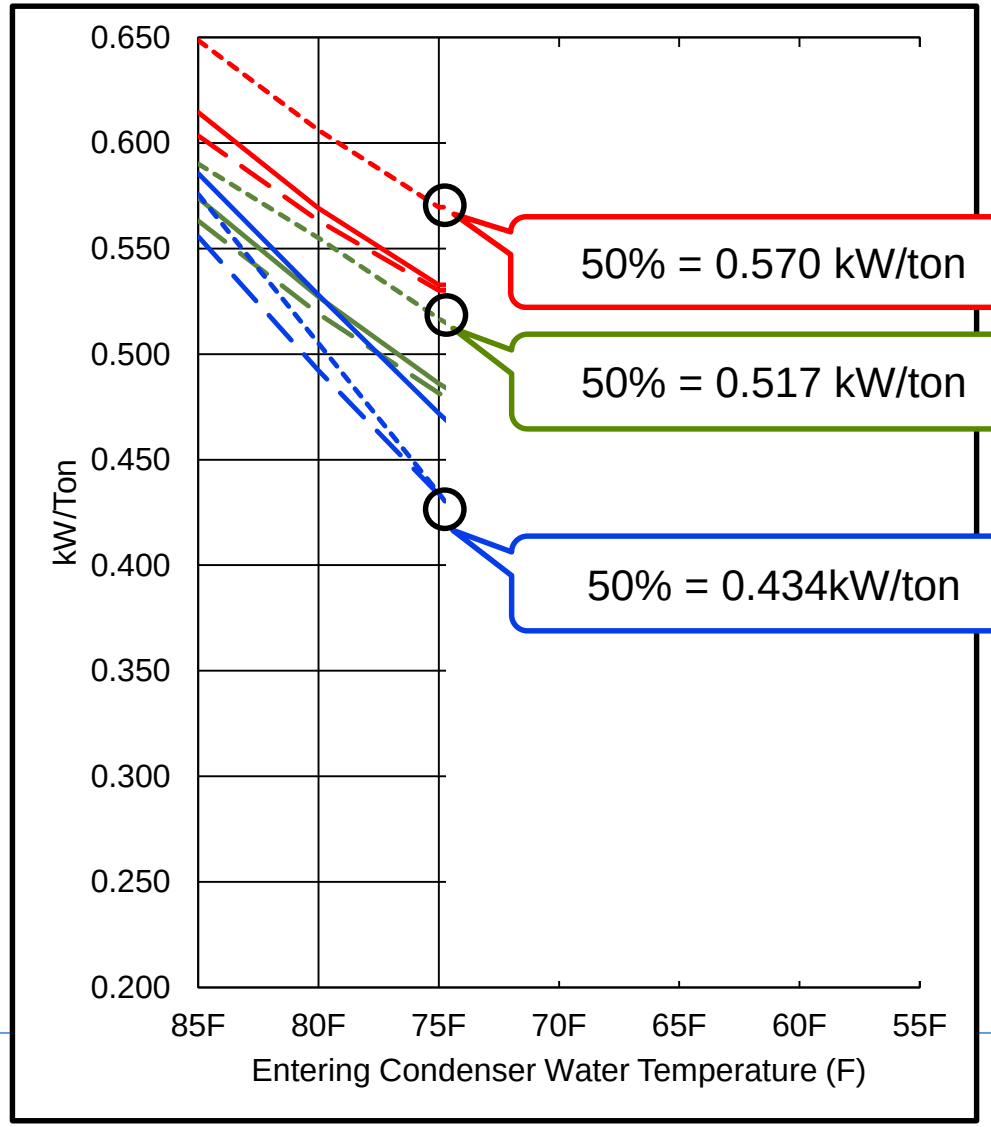
Variable Speed w/ Variable Orifice

Assume 500ton chiller
50% load - difference of 20.75kW

Johnson Controls

Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

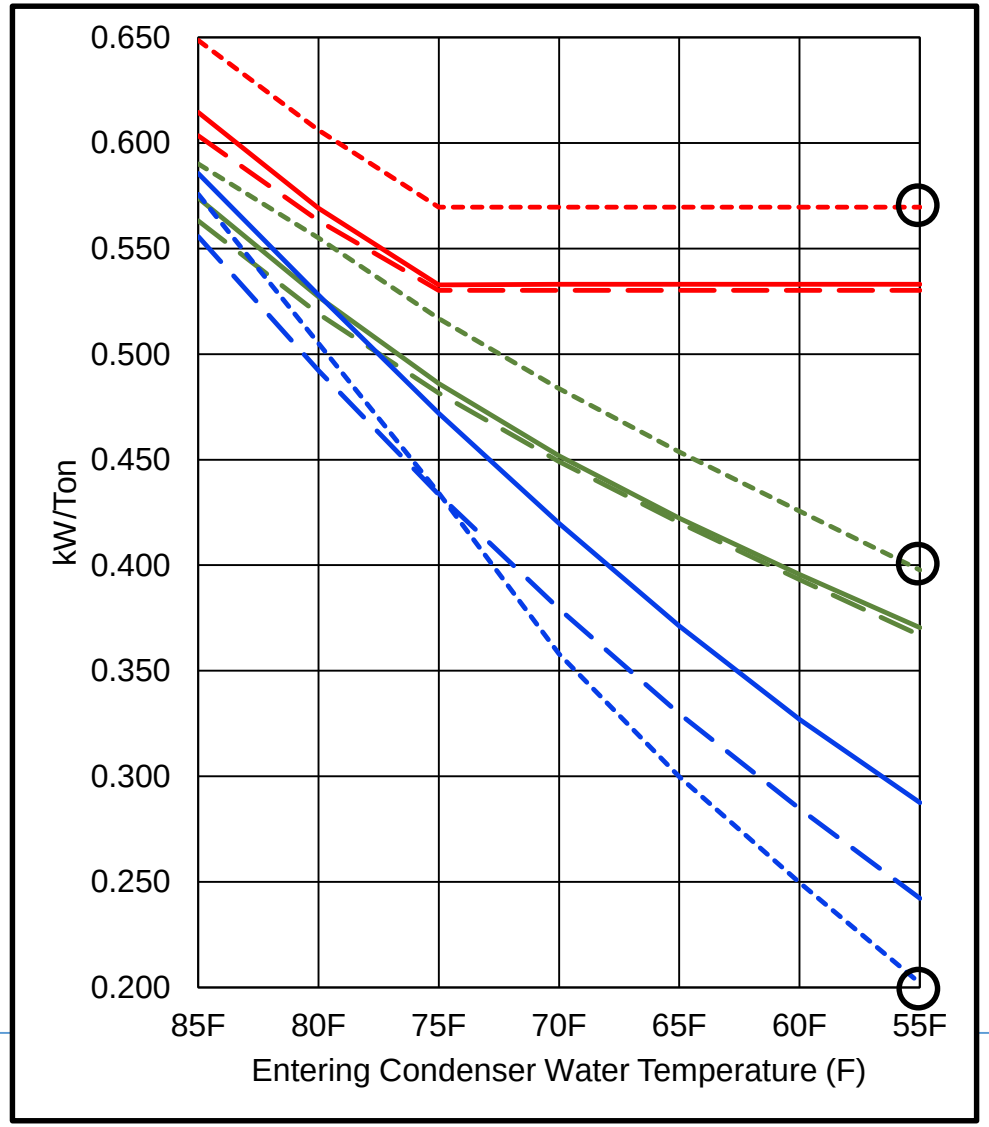
Variable Speed w/ Variable Orifice

Assume 500ton chiller
50% load - difference of 34kW

Johnson Controls

Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

50% Load
100% Load
80% Load

New - Constant Speed w/ Variable Orifice

50% Load
100% Load
80% Load

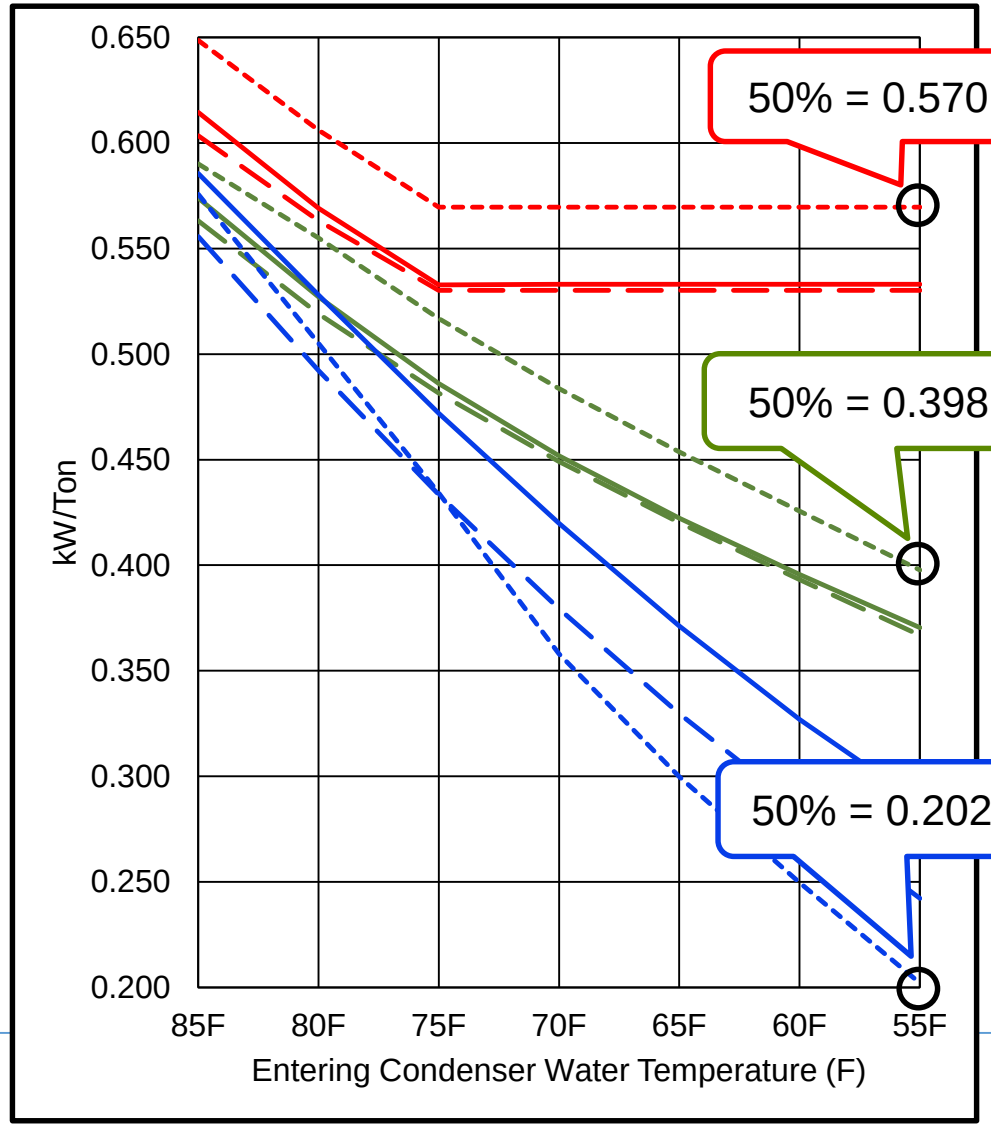
Variable Speed w/ Variable Orifice

100% Load
80% Load
50% Load

Johnson Controls

Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

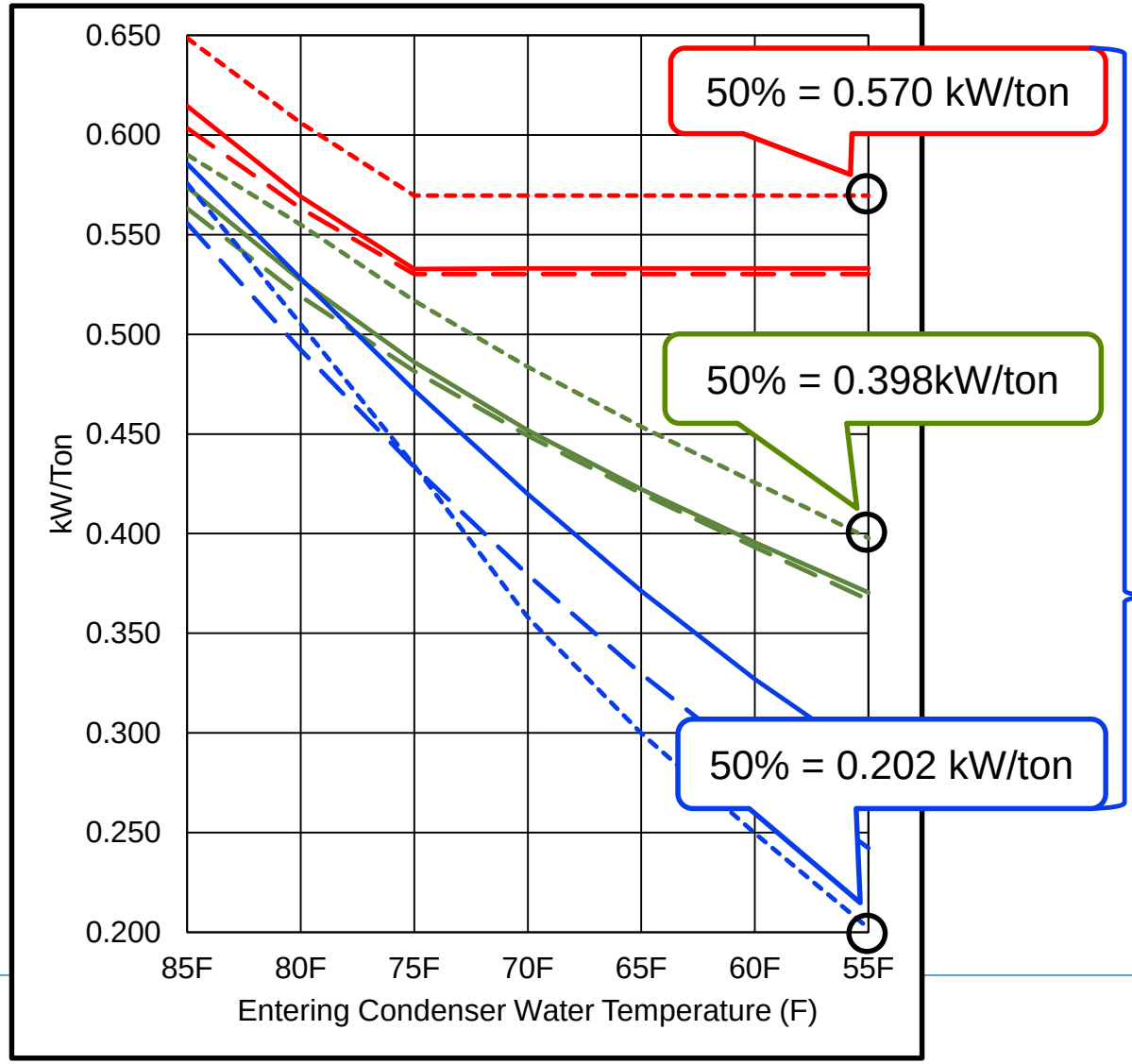
Variable Speed w/ Variable Orifice

Assume 500ton chiller
50% load - difference of 49kW

Johnson Controls

Real World Energy Performance

Fixed Speed vs Variable Speed



Traditional – Constant Speed w/ Fixed Orifice

New - Constant Speed w/ Variable Orifice

Variable Speed w/ Variable Orifice

Assume 500ton chiller
50% load - difference of 92kW

Johnson Controls

Innovations and Product Features

YORK *OptiSpeed™ VSD*

Unit mounted low voltage

- 460/575/600 V – 60 hz
- 380/400 – 50 hz

Floor mounted medium voltage

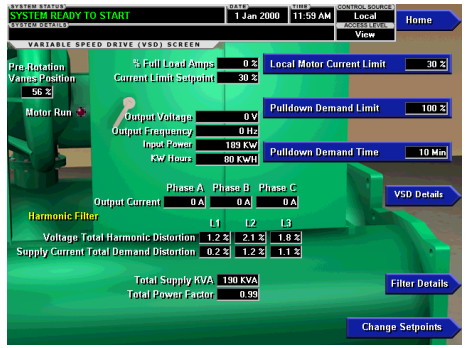
- 2300/3300/4000/4160 – 60 hz
- 3300 – 50 hz

Floor mounted **high** voltage

- 6.6kV/12.4kV/13.2kV/13.8kV – 60hz
- 6.6kV/10kV/11kV – 50hz

Benefits

- Full OptiView Communications
- YORK patented Adaptive Capacity Control
- Self learning for maximum efficiency



Johnson Controls

Can a VSD save energy on applications with constant load year round?

Johnson Controls

Can a VSD save energy on applications with constant load year round?

- Data Center Applications
- Process Cooling Applications

Johnson Controls

VSD Use in a Constant Load Application

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

VSD Use in a Constant Load Application

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261	0.5119	0.4982	0.4915	0.4952	0.5084	0.5373	0.5953	0.7965	-
80.00°	0.4713	0.4532	0.4411	0.4335	0.4310	0.4377	0.4568	0.5061	0.6496	1.303
75.00°	0.4179	0.3995	0.3866	0.3783	0.3700	0.3757	0.3914	0.4214	0.5341	1.067
70.00°	0.3686	0.3499	0.3353	0.3240	0.3163	0.3138	0.3240	0.3488	0.4028	0.8141
65.00°	0.3258	0.3046	0.2880	0.2748	0.2652	0.2580	0.2613	0.2801	0.3188	0.6505
60.00°	0.2866	0.2639	0.2443	0.2287	0.2171	0.2087	0.2059	0.2175	0.2463	0.3741
55.00°	0.2510	0.2265	0.2049	0.1869	0.1730	0.1632	0.1571	0.1611	0.1798	0.2555
50.00°	0.2214	0.1936	0.1694	0.1502	0.1338	0.1198	0.1118	0.1082	0.1173	0.1592
45.00°	0.2043	0.1742	0.1468	0.1260	0.1030	0.08859	0.07884	0.08250	0.1263	0.2195
40.00°	0.1996	0.1729	0.1481	0.1255	0.09586	0.08172	0.07135	0.08988	0.1443	0.2233
39.00°	0.1995	0.1729	0.1483	0.1262	0.09614	0.08209	0.07116	0.08865	0.1429	0.2229
38.00°	0.1996	0.1732	0.1486	0.1267	0.09662	0.08318	0.07134	0.08744	0.1413	0.2225
37.00°	0.2000	0.1737	0.1490	0.1273	0.09841	0.08454	0.07247	0.08625	0.1397	0.2220
36.00°	0.2006	0.1744	0.1495	0.1279	0.1015	0.08593	0.07361	0.08508	0.1379	0.2215

*Values are in kW/Ton.R

VSD Use in a Constant Load Application

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

No HPC needed

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261	0.5119	0.4982	0.4915	0.4952	0.5084	0.5373	0.5953	0.7965	-
80.00°	0.4713	0.4532	0.4411	0.4335	0.4310	0.4377	0.4568	0.5061	0.6496	1.303
75.00°	0.4179	0.3995	0.3866	0.3783	0.3700	0.3757	0.3914	0.4214	0.5341	1.067
70.00°	0.3686	0.3499	0.3353	0.3240	0.3163	0.3138	0.3240	0.3488	0.4028	0.8141
65.00°	0.3258	0.3046	0.2880	0.2748	0.2652	0.2580	0.2613	0.2801	0.3188	0.6505
60.00°	0.2866	0.2639	0.2443	0.2287	0.2171	0.2087	0.2059	0.2175	0.2463	0.3741
55.00°	0.2510	0.2265	0.2049	0.1869	0.1730	0.1632	0.1571	0.1611	0.1798	0.2555
50.00°	0.2214	0.1936	0.1694	0.1502	0.1338	0.1198	0.1118	0.1082	0.1173	0.1592
45.00°	0.2043	0.1742	0.1468	0.1260	0.1030	0.08859	0.07884	0.08250	0.1263	0.2195
40.00°	0.1996	0.1729	0.1481	0.1255	0.09586	0.08172	0.07135	0.08988	0.1443	0.2233
39.00°	0.1995	0.1729	0.1483	0.1262	0.09614	0.08209	0.07116	0.08865	0.1429	0.2229
38.00°	0.1996	0.1732	0.1486	0.1267	0.09662	0.08318	0.07134	0.08744	0.1413	0.2225
37.00°	0.2000	0.1737	0.1490	0.1273	0.09841	0.08454	0.07247	0.08625	0.1397	0.2220
36.00°	0.2006	0.1744	0.1495	0.1279	0.1015	0.08593	0.07361	0.08508	0.1379	0.2215

*Values are in kW/Ton.R

VSD Use in a Constant Load Application

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261	0.5119	0.4982	0.4915	0.4952	0.5084	0.5373	0.5953	0.7965	-
80.00°	0.4713	0.4532	0.4411	0.4335	0.4310	0.4377	0.4568	0.5061	0.6496	1.303
75.00°	0.4179	0.3995	0.3866	0.3783	0.3700	0.3757	0.3914	0.4214	0.5341	1.067
70.00°	0.3686	0.3499	0.3353	0.3240	0.3163	0.3138	0.3240	0.3488	0.4028	0.8141
65.00°	0.3258	0.3046	0.2880	0.2748	0.2652	0.2580	0.2613	0.2801	0.3188	0.6505
60.00°	0.2866	0.2639	0.2443	0.2287	2171	0.2087	0.2059	0.2175	0.2463	0.3741
55.00°	0.2510	0.2265	0.2049	0.1869		0.1632	0.1571	0.1611	0.1798	0.2555
50.00°	0.2214	0.1936	0.1694	0.1502	0.	1198	0.1118	0.1082	0.1173	0.1592
45.00°	0.2043	0.1742	0.1468	0.1260	0.1030		0.07884	0.08250	0.1263	0.2195
40.00°	0.1996	0.1729	0.1481	0.1255	0.09586		0.07135	0.08988	0.1443	0.2233
39.00°	0.1995	0.1729	0.1483	0.1262	0.09614	0.08209	0.07116	0.08865	0.1429	0.2229
38.00°	0.1996	0.1732	0.1486	0.1267	0.09662	0.08318	0.07134	0.08744	0.1413	0.2225
37.00°	0.2000	0.1737	0.1490	0.1273	0.09841	0.08454	0.07247	0.08625	0.1397	0.2220
36.00°	0.2006	0.1744	0.1495	0.1279	0.1015	0.08593	0.07361	0.08508	0.1379	0.2215

*Values are in kW/Ton.R

No HPC needed

VSD Use in a Constant Load Application (100% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 500 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261	0.5119	0.4982	0.4915	0.4952	0.5084	0.5373	0.5953	0.7965	-
80.00°	0.4713	0.4532	0.4411	0.4335	0.4310	0.4377	0.4568	0.5061	0.6496	1.303
75.00°	0.4179	0.3995	0.3866	0.3783	0.3700	0.3757	0.3914	0.4214	0.5341	1.067
70.00°	0.3686	0.3499	0.3353	0.3240	0.3163	0.3138	0.3240	0.3488	0.4028	0.8141
65.00°	0.3258	0.3046	0.2880	0.2748	0.2652	0.2580	0.2613	0.2801	0.3188	0.6505
60.00°	0.2866	0.2639	0.2443	0.2287	0.2171	0.2087	0.2059	0.2175	0.2463	0.3741
55.00°	0.2510	0.2265	0.2049	0.1869	0.1730	0.1632	0.1571	0.1611	0.1798	0.2555
50.00°	0.2214	0.1936	0.1694	0.1502	0.1338	0.1198	0.1118	0.1082	0.1173	0.1592
45.00°	0.2043	0.1742	0.1468	0.1260	0.1030	0.08859	0.07884	0.08250	0.1263	0.2195
40.00°	0.1996	0.1729	0.1481	0.1255	0.09586	0.08172	0.07135	0.08988	0.1443	0.2233
39.00°	0.1995	0.1729	0.1483	0.1262	0.09614	0.08209	0.07116	0.08865	0.1429	0.2229
38.00°	0.1996	0.1732	0.1486	0.1267	0.09662	0.08318	0.07134	0.08744	0.1413	0.2225
37.00°	0.2000	0.1737	0.1490	0.1273	0.09841	0.08454	0.07247	0.08625	0.1397	0.2220
36.00°	0.2006	0.1744	0.1495	0.1279	0.1015	0.08593	0.07361	0.08508	0.1379	0.2215

*Values are in kW/Ton.R

VSD Use in a Constant Load Application (100% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 500 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261									
80.00°	0.4713									
75.00°	0.4179									
70.00°	0.3686									
65.00°	0.3258									
60.00°	0.2866									
55.00°	0.2510									
50.00°	0.2214									
45.00°	0.2043									
40.00°	0.1996									
39.00°	0.1995									
38.00°	0.1996									
37.00°	0.2000									
36.00°	0.2006									

*Values are in kW/Ton.R

VSD Use in a Constant Load Application (100% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 500 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261									
80.00°	0.4713									
75.00°	0.4179									
70.00°	0.3686									
65.00°	0.3258									
60.00°	0.2866									
55.00°	0.2510									
50.00°	0.2214									
45.00°	0.2043									
40.00°	0.1996									
39.00°	0.1995									
38.00°	0.1996									
37.00°	0.2000									
36.00°	0.2006									

*Values are in kW/Ton.R

Consuming 263.05kW

Consuming 125.5kW

VSD Use in a Constant Load Application (100% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 500 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261									
80.00°	0.4713									
75.00°	0.4179									
70.00°	0.3686									
65.00°	0.3258									
60.00°	0.2866									
55.00°	0.2510									
50.00°	0.2214									
45.00°	0.2043									
40.00°	0.1996									
39.00°	0.1995									
38.00°	0.1996									
37.00°	0.2000									
36.00°	0.2006									

*Values are in kW/Ton.R

Consuming 263.05kW

Reduction of 52%

Consuming 125.5kW

VSD Use in a Constant Load Application (100% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 500 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°	0.5261									
80.00°	0.4713									
75.00°	0.4179									
70.00°	0.3686									
65.00°	0.3258									
60.00°	0.2866									
55.00°	0.2510									
50.00°	0.2214									
45.00°	0.2043									
40.00°	0.1996									
39.00°	0.1995									
38.00°	0.1996									
37.00°	0.2000									
36.00°	0.2006									

*Values are in kW/Ton.R

Consuming 263.05kW

Consuming 125.5kW

If I didn't have a VSD then my kW/ton would be a 0.371 @ 55F ECWT

I.e. consumption would be 185.5kW vs 125.5kW

VSD Use in a Constant Load Application (50% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 250 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°						0.5084				
80.00°						0.4377				
75.00°						0.3757				
70.00°						0.3138				
65.00°						0.2580				
60.00°						0.2087				
55.00°						0.1632				
50.00°						0.1198				
45.00°						0.08859				
40.00°						0.08172				
39.00°						0.08209				
38.00°						0.08318				
37.00°						0.08454				
36.00°						0.08593				

*Values are in kW/Ton.R

VSD Use in a Constant Load Application (50% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 250 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°						0.5084				
80.00°						0.4377				
75.00°						0.3757				
70.00°						0.3138				
65.00°						0.2580				
60.00°						0.2087				
55.00°						0.1632				
50.00°						0.1198				
45.00°						0.08859				
40.00°						0.08172				
39.00°						0.08209				
38.00°						0.08318				
37.00°						0.08454				
36.00°						0.08593				

*Values are in kW/Ton.R

Consuming 127.1kW

Consuming 40.8kW

VSD Use in a Constant Load Application (50% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 250 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

Partload Data (Minimum Condenser Water Temperature)

CEFT (°F)	% LOAD									
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%
85.00°						0.5084				
80.00°						0.4377				
75.00°						0.3757				
70.00°						0.3138				
65.00°						0.2580				
60.00°						0.2087				
55.00°						0.1632				
50.00°						0.1198				
45.00°						0.08859				
40.00°						0.08172				
39.00°						0.08209				
38.00°						0.08318				
37.00°						0.08454				
36.00°						0.08593				

*Values are in kW/Ton.R

Consuming 127.1kW

Reduction of 68%

Consuming 40.8kW

VSD Use in a Constant Load Application (50% load)

Assume a 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

Evap temperature: 54/44F

Cond temperature: 85/94.3F

Constant evap and cond flow

FL: 0.5261kW/ton

IPLV: 0.3058kW/ton

Process requires constant 250 tons

YORK®

Project:
Unit Tag:
Engineer:
Customer:

Rating Program: LTS 1.0.6337
Software Version: YW 17.02c
Date: 06/07/2017 14:37:10

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36.00°						0.08593				

*Values are in kW/Ton.R

Consuming 127.1kW

Consuming 40.8kW

If I didn't have a VSD then my kW/ton would be a 0.398 @ 55F ECWT

I.e. consumption would be 99.5kW vs 40.8kW

Running More Chillers in Part-load vs Full-load

Assume a 2x 500ton YMC² Chiller (Mag Bearing)

VSD chiller only!

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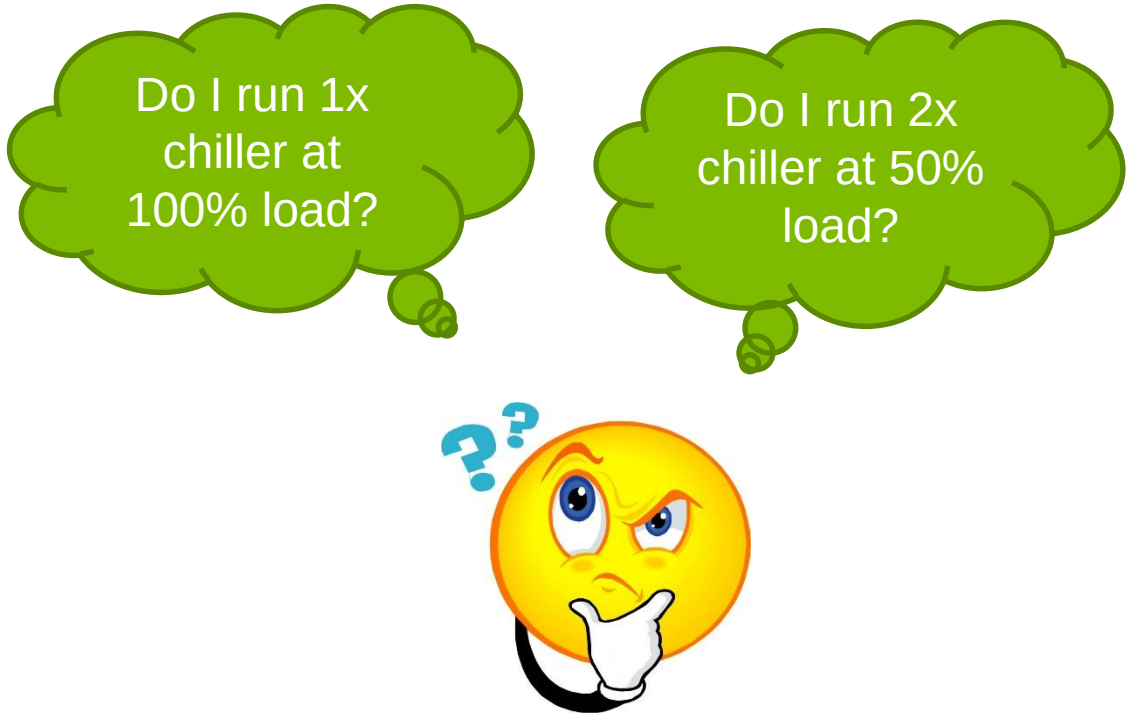

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85.00°	0.5261	0.5119	0.4982	0.4915	0.4952	0.5084	0.5373	0.5953	0.7965	-
80.00°	0.4713	0.4532	0.4411	0.4335	0.4310	0.4377	0.4568	0.5061	0.6496	1.303
75.00°	0.4179	0.3995	0.3866	0.3783	0.3700	0.3757	0.3914	0.4214	0.5341	1.067
70.00°	0.3686	0.3499	0.3353	0.3240	0.3163	0.3138	0.3240	0.3488	0.4028	0.8141
65.00°	0.3258	0.3046	0.2880	0.2748	0.2652	0.2580	0.2613	0.2801	0.3188	0.6505
60.00°	0.2866	0.2639	0.2443	0.2287	0.2171	0.2087	0.2059	0.2175	0.2463	0.3741
55.00°	0.2510	0.2265	0.2049	0.1869	0.1730	0.1632	0.1571	0.1611	0.1798	0.2555
50.00°	0.2214	0.1936	0.1694	0.1502	0.1338	0.1198	0.1118	0.1082	0.1173	0.1592
45.00°	0.2043	0.1742	0.1468	0.1260	0.1030	0.08859	0.07884	0.08250	0.1263	0.2195
40.00°	0.1996	0.1729	0.1481	0.1255	0.09586	0.08172	0.07135	0.08988	0.1443	0.2233
39.00°	0.1995	0.1729	0.1483	0.1262	0.09614	0.08209	0.07116	0.08865	0.1429	0.2229
38.00°	0.1996	0.1732	0.1486	0.1267	0.09662	0.08318	0.07134	0.08744	0.1413	0.2225
37.00°	0.2000	0.1737	0.1490	0.1273	0.09841	0.08454	0.07247	0.08625	0.1397	0.2220
36.00°	0.2006	0.1744	0.1495	0.1279	0.1015	0.08593	0.07361	0.08508	0.1379	0.2215

*Values are in kW/Ton.R

Running More Chillers in Part-load vs Full-load

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37.00°										
36.00°										

*Values are in kW/Ton.R

Consumption of 208.95kW

Each YMC² (2x) consumes
93.9kW
Total = 187.85kW
Reduction of ~10%

Controls

Running More Chillers in Part-load vs Full-load

Assume a 2x 500ton YMC² Chiller (Mag Bearing)

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Depending on your pumping strategy and cooling tower set up, you may have to turn on an additional pump or tower

YORK®

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Unit Tag:
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50.00°										
45.00°										
40.00°										
39.00°										
38.00°										
37.00°										
36.00°										

*Values are in kW/Ton.R

Consumption of 125.5kW

Each YMC² (2x) consumes
40.8kW
Total = 81.6kW
Reduction of ~35%

Controls

Running More Chillers in Part-load vs Full-load

What about additional run hours since I am running 2 chillers??

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Running More Chillers in Part-load vs Full-load

What about additional run hours since I am running 2 chillers??

YORK centrifugal compressor designs **DO NOT** require a 40,000 hour compressor teardown

A typical chiller requires:

- Inspection of bearing wear, gears, etc. within the driveline
- Can cost approximately $50,000+ per chiller every 10 years (4000 run hours a year)

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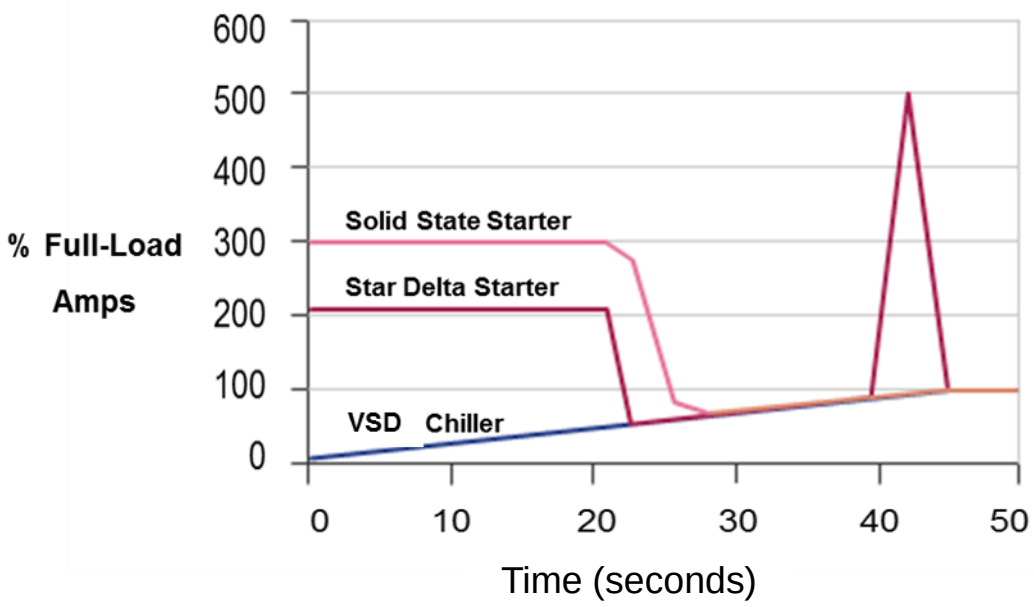
Additional VSD Benefits

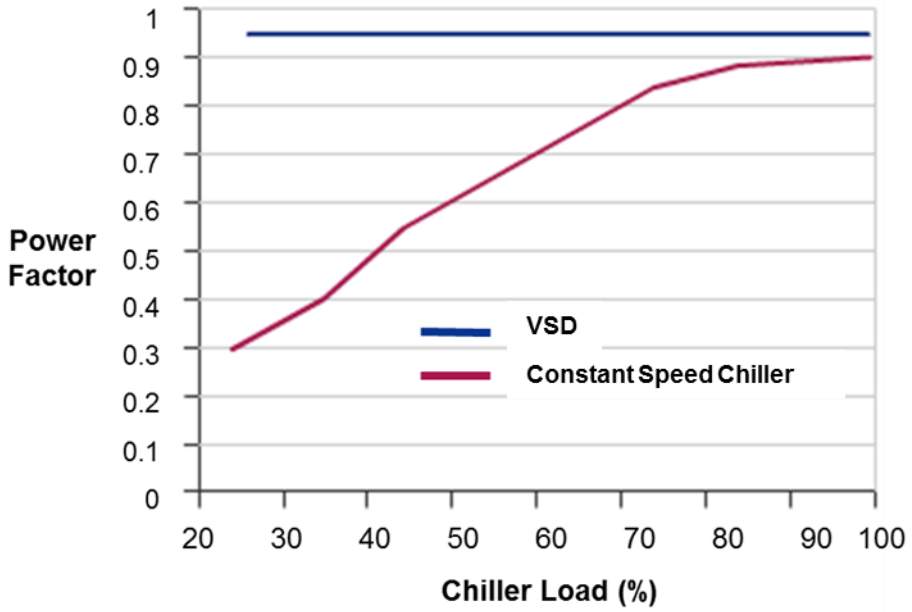
Zero Inrush

VSD reduces generator and no anti-recycle timer



High Power Factor

Eliminates the fear of power factor penalties by the utility company



Air-Cooled Screw Chillers

Redesign of Air-Cooled Screw Chillers in 2004

- Removal of “Slide Valves”
  - 50% less moving parts
  - 35% less leak paths
- Compressor speed varies due to the VSD
  - Compressors are now re-engineered

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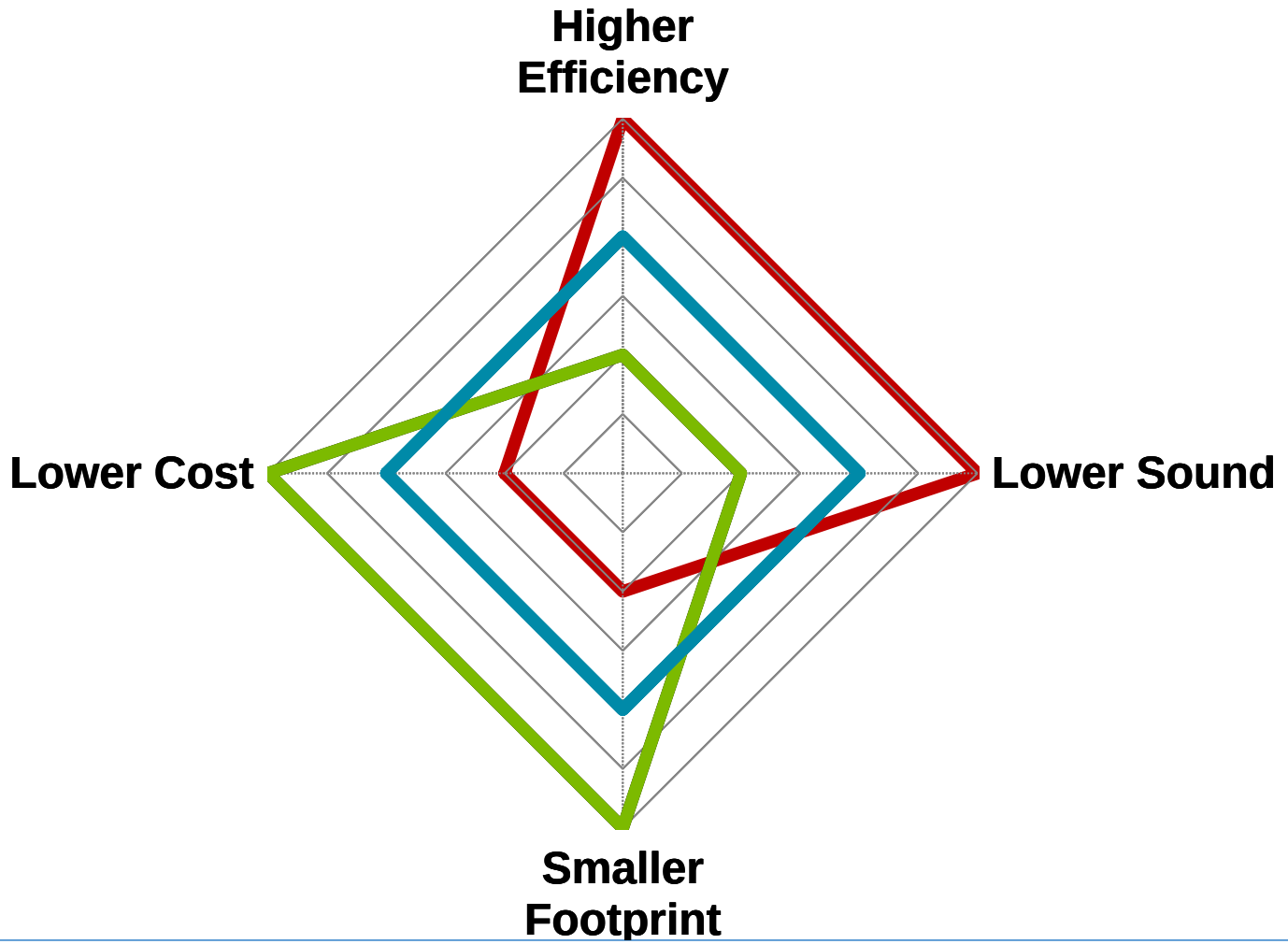
Air-Cooled Chillers

Tailor and Tune



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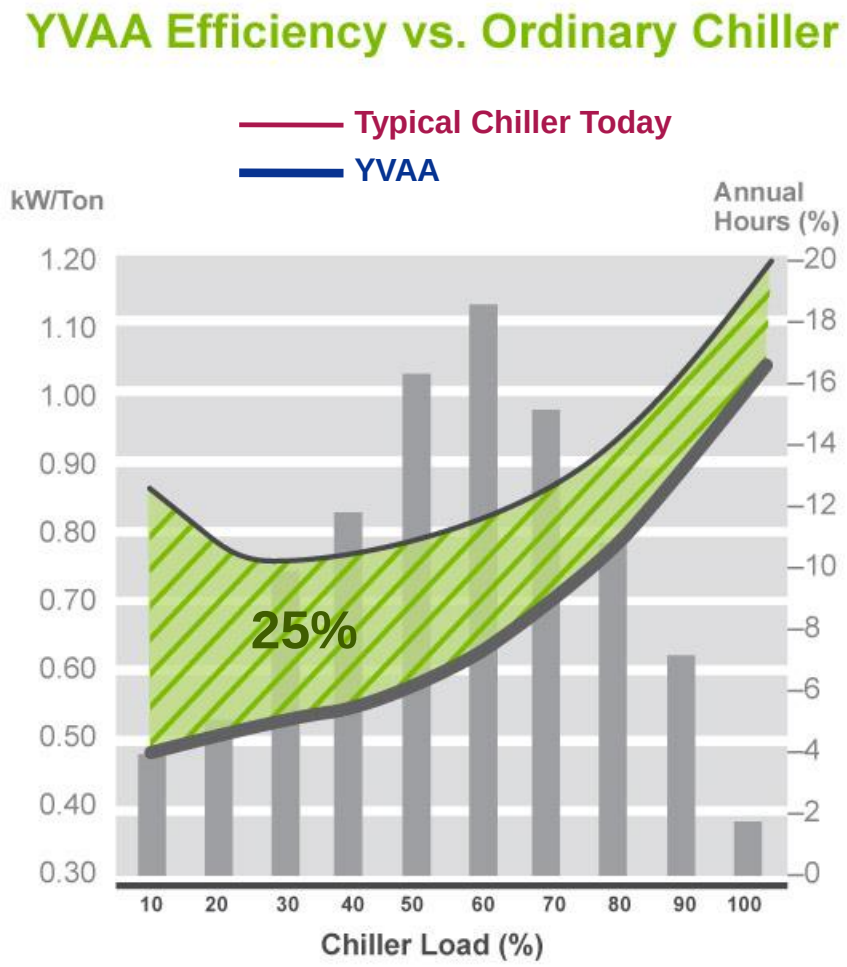
Air-Cooled Chillers

Tailor and Tune

VSD technology on Air-Cooled Screw Chillers

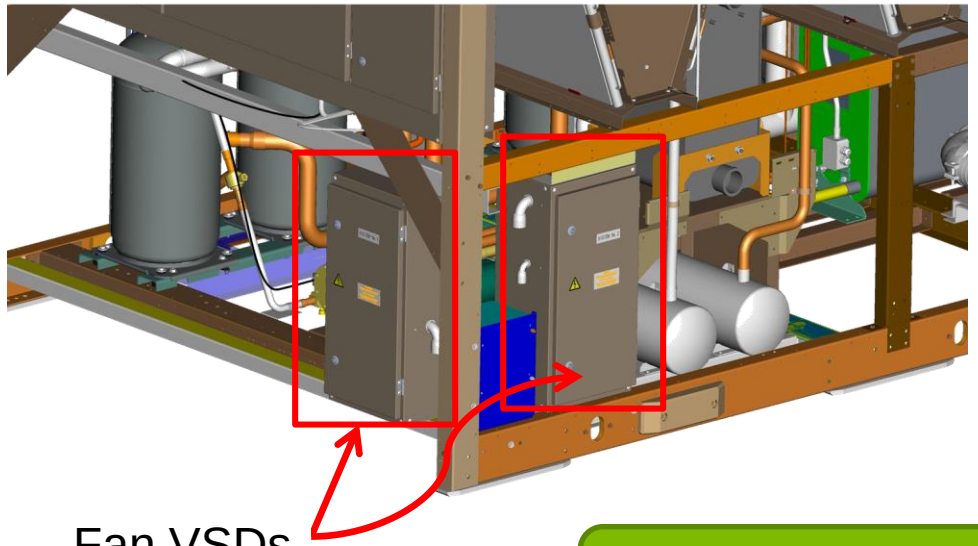
- Vastly improves the efficiency
- Greater energy savings in the year
- Flexible configurations
- Optimization for operating conditions



VSD on Condenser Fans

Placement of a VSD on each condenser fan circuit improves efficiency ~10%

YLAA Model*	AHRI Tons	Fixed Speed IPLV	VSD Fan IPLV	Payback (years)**
0058HE	57.0	15.6	16.8	**1.8**
0092HE	85.7	16.1	17.5	**1.3**
0142HE	129.5	15.9	17.1	**1.1**
0156HE	144.5	15.5	17.1	**0.7**
0175HE	172.5	15.6	17.1	**0.7**



Fan VSDs
(one per system)

8 fan unit -> Each VSD controls 4x fans

*listing only a few models, VSD fans applicable for both screw and scroll chillers
**Payback may vary based on your building parameters

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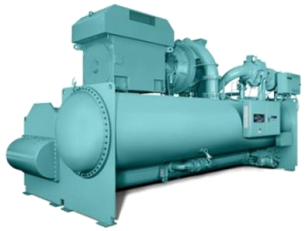
YORK Variable Speed Chiller Offering

Model YK
Single
Compressor



Model YKEP
Centrifugal
Extended Capacity

Model YD
Dual
Compressors

Model CYK
Compound Compressors

Model YMC²
Magnetic
Centrifugal

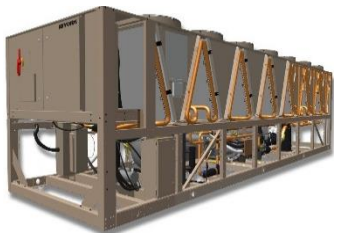
YORK®

INSTALL CONFIDENCE

Model OM
Custom
Designed

Model YVWA
VSD Screw Unit

Model YVAA
VSD Air-Cooled Screw Chiller



Model YVFA
VSD Air-Cooled Screw Chiller
w/ Integrated Free Cooling

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What else utilizes VSD's in todays HVAC industry?

Air Handlers

Cooling Towers

Pumps

VRF Systems

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Conclusion

- Real World Efficiency
- Lift provided enormous energy savings on chillers
- More chillers operating is more efficient
- Constant load with VSD saves money

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coolingbestpractices.com

When to Install VSD Chillers

Q&A

Please submit any questions through the Question Window on your GoToWebinar interface, directing them to Chiller & Cooling Best Practices Magazine. Our panelists will do their best to address your questions, and will follow up with you on anything that goes unanswered during this session.

Thank you for attending!

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IoT and Compressed Air Management Systems

Tim Dugan
Compression Engineering Corporation
Keynote Speaker

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